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AND

THE OPHTHALMOSCOPE.

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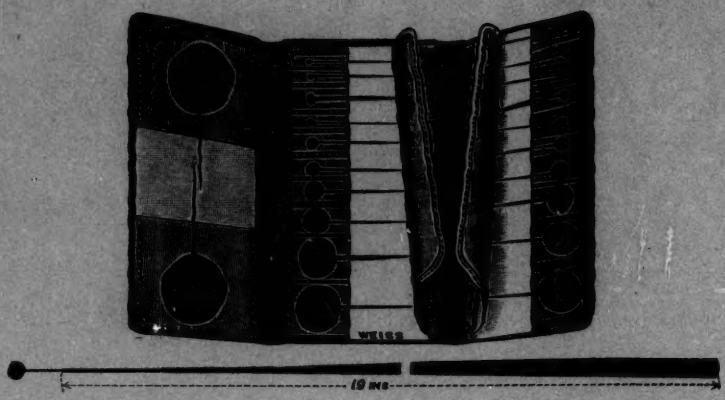

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THE BRITISH JOURNAL
OF
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JANUARY, 1917.

FOREWORD.

READERS who have not taken part in the founding of this new journal may wonder that such an enterprise should be set on foot at the present time. The reason is easily given. The stress of war has compelled all sorts and conditions of men to ask themselves how they can better utilise their resources and increase the efficiency of their work. In countless ways they are finding that "union is strength."

THE BRITISH JOURNAL OF OPHTHALMOLOGY comes into existence through the union of three well-known periodicals: *The Reports of the Royal London Ophthalmic Hospital*, *The Ophthalmic Review*, and *The Ophthalmoscope*.

It is now nearly sixty years since the Staff at Moorfields began to issue periodical *Reports* of their clinical and operative experiences, and of the researches carried out in the museum and laboratories of the Hospital. Established in 1857, these invaluable *Reports* now fill twenty volumes. *The Ophthalmic Review* appeared in 1881. Its purpose was to give critical notices and abstracts of current ophthalmic literature, especially of that published abroad, and to provide a channel for the prompt publication of short original papers. It has carried on this work without a break for thirty-five years. *The Ophthalmoscope*, the youngest of the three, was established in 1903. It quickly attained a high place in the estimation of ophthalmic surgeons, and a wide circulation.

It would be impertinent to praise the work accomplished by these periodicals. Every student of the subject knows that they have played important parts in the progress of ophthalmology. But they have been carried on independently of each other, and their work has sometimes overlapped; this implies waste of strength.

The time is opportune for their unification, and their promoters are willing, and more than willing, to join forces in a more comprehensive enterprise.

The new Journal is already assured of welcome and support in all parts of the British Empire, and there is reason to believe that the hospitality of its pages will be gladly accepted from time to time by ophthalmic surgeons in Holland, Sweden, and some other countries whose original work has hitherto been published elsewhere.

It is placed on firm foundations. It is the property not of individuals, but of a limited liability Company, the declared object of which is to further the study of ophthalmology rather than to earn large dividends. Every British ophthalmic surgeon has been asked to be a shareholder in the Company, as well as a subscriber to the Journal. There has been an admirable response. The literary conduct of the Journal is in experienced hands: the Editor is Mr. Sydney Stephenson, the Sub-Editor is Mr. Erskine Henderson, and they act under an Editorial Committee, of which Mr. J. B. Lawford is the Chairman.

The prime mover in this new development deserves the cordial thanks of all whom it concerns. Mr. W. H. H. Jessop saw the opportunity and seized it. By his position as President of the Ophthalmological Society of the United Kingdom, and not less by his own personality, he was the very man to initiate the scheme, and to carry it with general approval into operation. May his foresight and unselfish zeal find a fitting monument in its success.

But lasting success, be it remembered, is not ensured by an enthusiastic send-off, nor does it depend only on the ability and experience of those who conduct the undertaking; it demands the devotion of many workers. Writing in the first number of the *Moorfields Reports*, Sir William Bowman referred to those "who would fain leave science more advanced than they found it." Let every reader of THE BRITISH JOURNAL OF OPHTHALMOLOGY seek earnestly for opportunities of contributing in this spirit to its pages, and it will assuredly be worthy of its name. P.S.

AN AMERICAN APPRECIATION.

The following generous appreciation (somewhat abridged) of the action which has led to the formation of THE BRITISH JOURNAL OF OPHTHALMOLOGY appeared in the October, 1916, number of our contemporary, *Ophthalmic Literature*, edited by Edward Jackson, of Denver, Colorado:

Combination of English Journals.

Publication of *The Royal London Ophthalmic Hospital Reports* began in 1857. From the start they had more the character of an ophthalmic journal than of hospital reports. A very important feature of the earlier volumes was a department devoted to abstracts of the ophthalmic literature of other countries. This department was discontinued after 1864, but in the later years a majority of the articles published have not been devoted to the work of the hospital. The chief justification for its name has always been that it was conducted and written by men who had been connected with the hospital as surgeons, assistants, and students. In the last number issued, bearing the date of March, 1916, the leading article is a series of historical notes by the late George Coats.

In 1862 a journal, called *The Ophthalmic Review*, was started by T. Z. Lawrence, assisted by Thomas Windsor, but this was discontinued after a few years. In 1881 the present journal of that name was started by Karl Grossman, of Liverpool, and Priestley Smith, of Birmingham. With the exception of a few months, during the sickness of its then editor, N. M. Maclehose, it has been issued regularly to the present year. In 1903 Sydney Stephenson commenced the publication of *The Ophthalmoscope*, which immediately developed into a very important journal, and has continued to appear regularly to the present time.

Although it was not very apparent in their pages, the pressure of war has been severely felt by those who have had to bear the burden of these publications. Their separate maintenance has been a difficult problem; and the difficulty increased until combination suggested itself and became the practical solution of the situation. With the beginning of the new year, they will be merged into a single journal, THE BRITISH JOURNAL OF OPHTHALMOLOGY. The combined journal will be edited, under the supervision of a committee, by Mr. Sydney Stephenson and an assistant editor.

We had occasion a few months since to refer to the combination of two of the leading Italian journals, as a step in preparation for the new life expected to develop in all branches of the higher learning with the close of the present war. We have no doubt that this combination of British ophthalmic forces will prove an important step in the same direction; and the new journal will take a leading place, perhaps the leading place, in the world's literature of ophthalmology.

COMMUNICATIONS.

THE BLOOD-PRESSURE IN THE EYE AND ITS RELATION TO THE CHAMBER-PRESSURE.

BY

PRIESTLEY SMITH,

EMERITUS PROFESSOR OF OPHTHALMOLOGY, BIRMINGHAM UNIVERSITY.

A BETTER knowledge of the blood-pressure in the interior of the eye would help towards the solution of several important problems. It would help us to understand how the fluid which fills the chambers is produced and removed, how its pressure is maintained, and how changes in this pressure come about. Especially we want to know the normal pressure in the capillaries of the ciliary processes. Current estimates differ. In a recent discussion on the subject, Professor Leonard Hill[1] maintained that the blood-pressure in the processes is about equal to the chamber-pressure, while Professor Starling gave reason for holding it to be higher than the chamber-pressure by at least 30 mm. Hg. My own contention was that whereas the pressure in the veins at their points of exit from the eye is about equal to the chamber-pressure, that in the capillaries must, in accordance with physical laws, be considerably higher. Since that time, by means of experiments on the pressure of water flowing through branching tubes, I have endeavoured to obtain a clearer idea of the pressure-changes which occur in the blood-stream as it passes through the eye.

The blood in the intra-ocular vessels, unlike the fluid in the chambers, moves with considerable velocity and consequently sufiers a loss of pressure between the points where it enters and leaves the eye. Under normal conditions its entrance-pressure is said to be about 100 mm. Hg. Its exit-pressure cannot be far from 25 mm. Hg. The evidence on which these estimates are based will be considered later; for our immediate purpose they may pass. We have then a fall of pressure of something like 75 mm. Hg. between the entrance and the exit points. How is this fall distributed? Does it take place chiefly on the arterial side of the capillaries, or on the venous side, or in the capillaries themselves? The present article approaches the question from the physical side, and deals firstly with the principles according to which a mass of liquid flowing through a tubular system loses pressure as it moves along.

To realize these principles effectively one needs the aid of practical demonstration—at least that is my own case. Hence the experiments. The manipulation was done for me by an assistant. We

experimented first with tubes of the simplest form, and then modified the arrangement step by step so as to arrive ultimately at a branching system comparable in some degree with arteries, capillaries and veins. Many unforeseen difficulties arose, and the problem proved much more intricate than was anticipated. Before describing the experiments it will be well to remind the reader of certain fundamental facts.

A mass of liquid flowing through a tube exhibits energy in two forms; kinetic or *employed* energy in the movement of the liquid; potential or *unemployed* energy in its pressure against the wall of the tube. We are here concerned chiefly with lateral pressure. This can be measured at any point by making an aperture in the wall of the tube, connecting a vertical tube therewith, the connection being strictly at right angles with the wall of the tube, and noting the height to which the liquid rises. Placing a number of such tubes at selected points, and drawing a line through the summits of the columns so obtained, we get a pressure-line which shows in a graphic way how the lateral pressure of the stream varies in different parts of its course.

The lateral pressure at any specified point is a measure of the resistance encountered by the stream between that point and the distal end of the tube. At the proximal end of the tube the pressure is at its maximum, for here the whole of the resistance lies ahead; at the distal end it is *nil*, for here resistance ceases; between the two it diminishes progressively, for the unemployed energy which it represents is progressively expended in overcoming the resistence—being converted into heat. Hence in the case of any given tube, if the resistance be greater in one region of the tube than elsewhere, the pressure-line over that region will slope more steeply than elsewhere.

The resistance encountered in the tube depends on friction in the liquid itself, for the particles in the axis of the stream move with greater velocity than those nearer to the outer surface. The outer surface of the liquid, provided it wets the tube-wall, is practically stationary, so that there is no friction between the liquid and the wall itself. In a given tube, the resistance increases when the velocity of the stream increases; it is also increased by raising the viscosity of the liquid or by lowering its temperature.

Figure 1 shows the general arrangement of the apparatus employed in our experiments. The charts show the pressure-lines obtained. They represent the lateral pressure of water at a temperature of 60°-65° F. flowing through small glass tubes arranged in various ways. They are true, be it noted, only as regards the points showing actual measurements; the straight connecting lines are arbitrary. Had measurements been taken at intermediate points, all the deflected pressure-lines would have been somewhat different in shape. Had

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such points been infinitely numerous, sharp angles and straight connecting lines would have been absent; when not straight from end to end the whole line would have been sinuous, for changes of resistance do not take place abruptly—they tend to spread. But angular lines suffice for the present purpose.

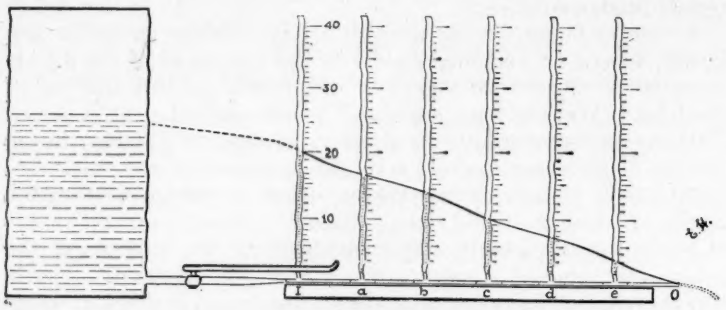

FIG. 1.

The water in the cistern, by its raised position, provides the energy that drives the stream through the horizontal tube. The tap admitting the water to the horizontal tube has a long handle, so that the rate of flow, and therewith the pressure at the point *I*, can be adjusted to a nicety.

The horizontal tube measures 60 cm. from *I* to *O*. *I* stands for inlet, *O* for outlet, and *c* is midway between the two. The vertical tubes show the lateral pressure of the water at the points over which they stand; they are graduated in millimetres, although centimetres only are shown in the drawing; they are large enough to obviate material error from capillarity. The tubes and systems to be tested are placed between *I* and *O*. They are built of segments connected end to end by short pieces of rubber tube. The vertical tubes are connected with the horizontal by means of T-pieces. Branching tubes are built by means of Y-pieces. In the making of the tubes, narrowing of the lumen at the points of branching was avoided—it is a source of error easily overlooked.

In the case of symmetrical tubes the readings were controlled by repeating each experiment after reversing the position of the tube, the proximal end in the first trial becoming the distal in the second; where differences were found the average was taken; the differences were small.

The readings were plotted on divided paper and the charts so obtained were reduced by photography with omission of the subdivisions. At the foot of each chart is shown the tube to which it refers—drawn somewhat too thick in proportion to its length. The larger numerals below the tube show the ratio of the cross-sections at the several points, and in the case of double and quadruple tubes they refer to the total cross-section. The smaller figures show the diameters of the single tubes.

Details of tubes chiefly employed.

Diameter	mm.	1.23	1.73	2.45	3.46	4.9	6.9
Square of diameter ...		1.5	3	6	12	24	48
Cross-section ...	sq. mm.	1,2	2.4	4.8	9.6	19.2	38.4
Ratio of cross-sections		0.5	1	2	4	8	16

In our earlier experiments we worked with a uniform "head" of water in the cistern, *viz.* 30 c.m. This proved inconvenient. The pressure at the point *I* is in every case lower than the cistern-pressure, for energy is spent in giving motion to the stream at its

exit from the cistern, and in overcoming resistance in the tap and nozzle; moreover, the difference between the pressure at *I* and that in the cistern differs in different tubes according to the velocity of the flow; hence a uniform cistern-pressure gives various pressures at *I*, and the pressure-lines of different tubes are not easily compared.

Later we worked with a uniform pressure at *I*, *viz.* 20 cm. This was obtained, irrespective of the precise amount of pressure in the cistern, by careful adjustment of the tap. The pressure-lines so obtained all start at the same height on the charts and are therefore easily compared. A comparable condition in the vascular system would be a uniform blood-pressure at the commencement of the aorta.

Tube A (Fig. 2) is straight and of uniform diameter—the simplest possible form. The water moves through it with uniform velocity and meets with the same amount of resistance in each unit of distance travelled. Energy is therefore uniformly expended, lateral pressure falls evenly, and the pressure-line is straight. A pressure of 20 cm. at *I* gave the upper line seen in the chart, a pressure of 10 cm. gave the lower; in each case the pressure at the half-way point equals the mean of the end-pressures.

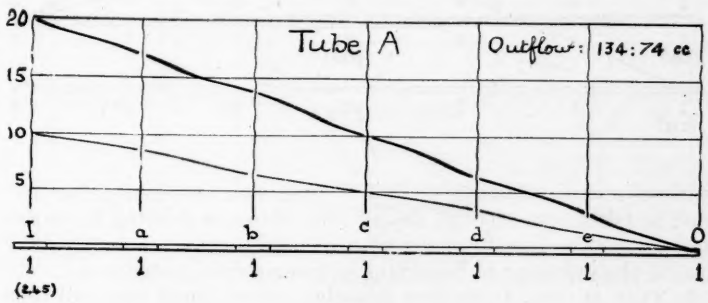

FIG. 2.

Tube B (Fig. 3) resembles the foregoing, except that it enlarges in the middle region. The cross-section at *c* is twice that at *b*; the velocity at *c* is therefore half that at *b*. The pressure-line changes with the change of velocity; it is pushed upwards over the middle region of the tube; the half-way pressure is greater than the mean of the end-pressures.

In contrast with the foregoing, Tube C (Fig. 3) diminishes in the middle. The cross-section is reduced here by one-half and the velocity is thereby doubled. The pressure-line is deflected downwards in the middle region; the half-way pressure is below the mean.

Tubes with greater enlargement in the middle region gave greater

upward displacement (see for example Tube L), and tubes with more contraction in the middle gave more downward displacement; but the foregoing examples are sufficient. They illustrate a principle:—*In a symmetrically-shaped horizontal tube of uniform diameter the half-way pressure equals the mean of the end-pressures; in one which enlarges in the middle the half-way pressure is greater than the mean; in one which diminishes in the middle it is less than the mean.*

Now, in one respect the vascular system of the body resembles a tube which enlarges in the middle: its aggregate cross-section enlarges progressively up to the half-way point and diminishes progressively beyond that point. But it is not a single tube and its

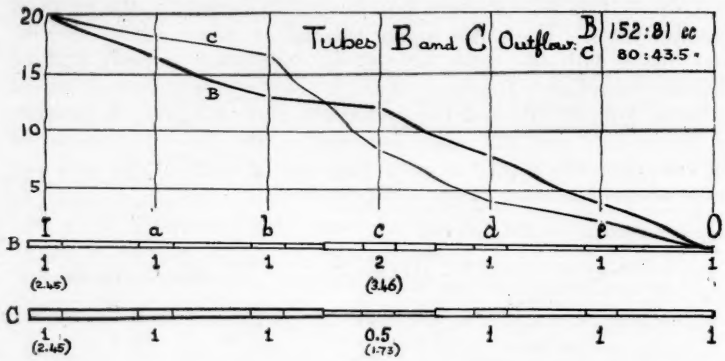

FIG. 3.

proximal and distal halves are not symmetrical, and these differences must be taken into account before any inference relating to blood-pressure can be based on the principle just stated. Let us first observe the influence of branching in *symmetrical* systems.

In Tube D (Fig. 4) the two branches are of equal size, and their aggregate cross-section equals that of the trunk. Consequently each

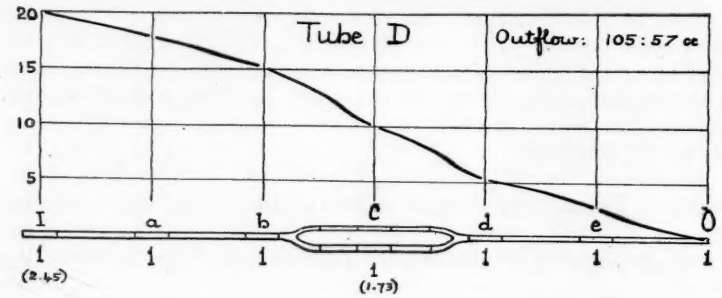

FIG. 4.

branch transmits one-half of the stream at the same rate as that at which the trunk transmits the whole: at *c* the velocity is the same as at *b* and *d*. As in the case of the single tube with uniform velocity throughout (Tube A) the half-way pressure equals the mean of the end-pressures, although here the resistance is not uniform throughout, but greater in the middle region, as shown by the varying slope of the pressure-line.

In Tube E (Fig. 5) each branch alone is equal to the trunk. At *c* therefore the total cross-section is double that at *b*, and the velocity is reduced to one half. As in the corresponding single tube B, the pressure-line is deflected upwards from its straight course; the pressure at the half-way point is above the mean.

In Tube F (Fig. 5), on the contrary, the total cross-section at *c* is half that at *b*, and the velocity is doubled. The pressure-line is deflected downwards; the pressure at *c* is below the mean.

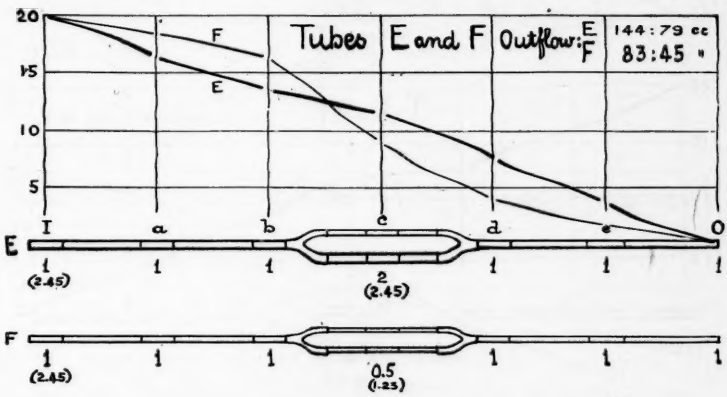

FIG. 5.

Tubes G and H (Figs. 6 and 7) carry the demonstration one step further. In G the branches arising at each bifurcation are together equal to the trunk from which they spring; the total cross-section at *c* is therefore equal to that at *b*, and the velocity is uniform throughout the whole system, as in Tubes A and D. Here again, with uniform velocity, we have the half-way pressure equal to the mean in spite of the repeated branching.

In Tube H, on the other hand, the branches are individually equal to the trunk; the total cross-section at *c* is therefore four times that at *b* and the velocity is reduced to one-fourth. As before, with lowered velocity at the half-way point the half-way pressure is above the mean.

But neither of these branching tubes represents the method of

branching which is usual in the case of blood-vessels. When an artery bifurcates the branches, as a rule, are neither collectively nor individually equal to the trunk; they are formed on an intermediate plan: together they are larger, singly they are smaller, than the

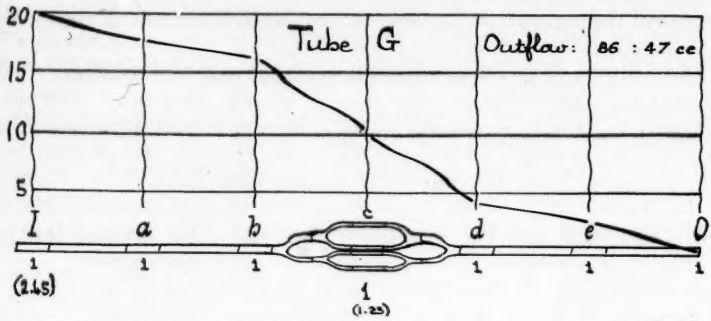

FIG. 6.

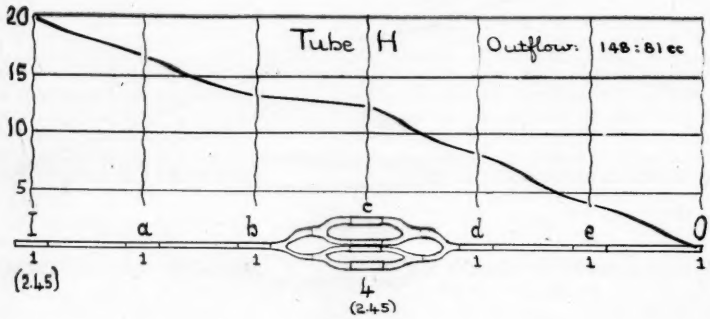

FIG. 7.

trunk. Tube J (Fig. 8) is built on such a plan. The total cross-section increases at each bifurcation, but less rapidly than in Tube H; it doubles in two bifurcations; at c it is twice as great as at *b*. The pressure-line is deflected upwards; the half-way pressure is above the mean, but less so than in the case of Tube H where the enlargement occurred more rapidly and was greater.

The experiment was carried further yet. Wishing to obtain conditions more nearly comparable with the vascular system, namely, a multitude of small channels with great extension of friction-surface as well as enlargement of cross-section in the middle region, and finding that branching tubes of still smaller size could not be made with the required accuracy, we proceeded in another way.

Tube K (Fig. 9) is identical with Tube J, save as regards the four

central T-pieces. These are larger than in Tube J, and are packed with capillary tubes. Instead of 4 tubes at c, we have now 36, and about twice as many small angular spaces between the tubes. The aggregate lumen at *c* is to that at *b* about as 6 to 1. The pressure-line differs little from that of Tube J; the half-way pressure is above the mean.

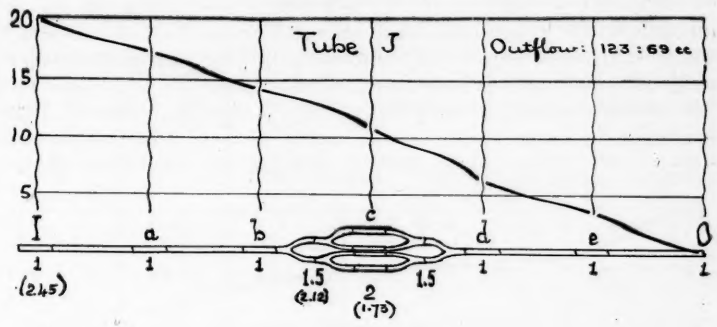

FIG. 8.

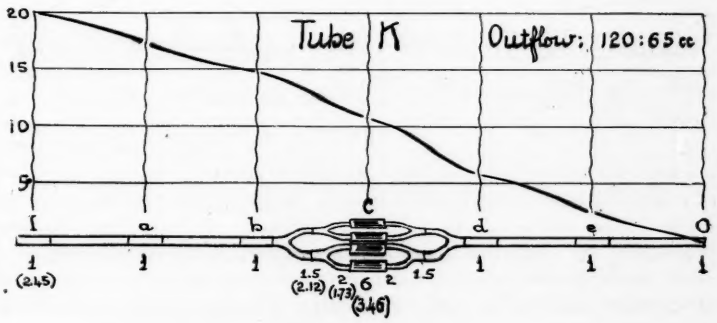

FIG. 9.

The capillary tubes were 20 mm. long, and shorter than the containing tubes by 5 mm. at each end, so that the water had easy access to them all. Each containing tube held 9 capillaries; the average diameter of the capillaries was about 0.9 mm. outside, 0.75 inside.

Evidently what we found to be true for symmetrical single tubes is true for symmetrical branching tubes also:—*If the aggregate cross section of the branches at the half-way point of a symmetrical branching tubular system is greater than the cross-section at the ends, the half-way pressure is greater than the mean of the end pressures.*

Now, the blood-stream enlarges greatly as it travels from the aorta to the capillaries—roughly about 600 times. We may therefore infer that if the vascular system were strictly symmetrical, *i.e.* if the veins were an exact counterpart of the arteries, and if the whole system were horizontal, the pressure in the capillaries would be greater than the mean of the pressures in the main trunks.

How much greater would it be? Consider the excess in some of the foregoing examples. The end-pressures in every case are 20 cm. and 0, the mean is therefore always 10 cm. In Tubes B and E the half-way pressure exceeds the mean by 1.8 and 1.7 cm. respectively, *i.e.* by 9 and 8.5 per cent. of the total fall. In Tube H it exceeds the mean by 10 per cent. of the total fall. But in these examples the cross-section in the middle is only twice as great as that at the ends. With greater enlargement we obtain greater

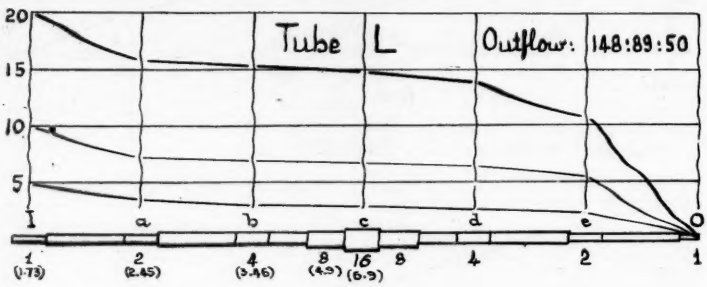

FIG. 10.

excess; for example, in Tube L (Fig. 10) where the cross-sections at *c* and *I* are as 16 to 1, the half-way pressure exceeds the mean by no less than 24 per cent. of the total fall. Now, in the vascular system of the body the ratio of enlargement in the middle region is very much greater still. May we, then, infer that if arteries and veins were alike in size and distribution, and the whole system were horizontal, the pressure in the capillaries would greatly exceed the mean of the pressures in the main trunks?

No. The results obtained so far do not justify this inference, for the amount of the excess in question varies, not only with the amount of enlargement in the middle region of the system, but also with the velocity and steadiness of the stream, and with the distribution of the resistance which has to be overcome. These factors must be taken into account, and the artificial streams must be compared with the blood-stream in these respects, before any inference of the kind can be safely drawn.

The influence of *velocity* on the excess of pressure at the half-way point of a given tube is seen when we alter the velocity. Changes

of velocity can be measured by measuring the amounts of liquid escaping from the tube in equal periods of time, for in a given *tube the outflow is directly proportional* to the velocity. In our experiments the outflow during periods of 60 seconds was measured by means of a tall measure-glass graduated in c.c., and the seconds hand of a watch. The results are shown on the charts.

Tube L, for example, was tested under three different pressures, *viz.* 20, 10, and 5 c.m. Lowering the pressure lowered the velocity of the stream, as shown by the diminished outflow—148, 89, 50 c.c. in 60 seconds, and at the same time the excess of pressure at the half-way point fell from 4.8 to 1.9 and 0.6 cm., *i.e.* from 24 to 19 and 12 per cent. of the total fall of the pressure-line. Here are the figures tabulated:

Tube L	Actual excess in c.m.	Equivalent percentage of total fall.	Outflow in c.c.
Under pressure 20 c.m.	4.8	24	148
„ „ 10 c.m.	1.9	19	89
„ „ 5 c.m.	0.6	12	50

In the self-same tube then the excess of pressure at the half-way point was smaller in relation to the total fall when the water flowed slowly than when it flowed fast.

Now the question of ***turbulence***. In a turbulent stream energy is expended in the formation of eddies, whirls, and back-currents; in a smoothly-flowing stream no energy is wasted in this way. It was necessary, therefore, to ascertain whether our artificial streams were smooth or turbulent, and to compare them with the blood-stream in this respect.

In the case of a steady stream the velocity is directly proportional to the pressure, e.g., if we double the pressure we double the velocity, and thereby double the outflow per unit of time. In a turbulent stream the velocity is *not* proportional to the pressure; when we double the pressure we fail to double the outflow, for more of the energy is wasted in the formation of eddies. Hence, to ascertain the character of a stream in this respect, we have only to measure the outflow under two known pressures, say 20 and 10 c.m. If we fail to halve the outflow when we halve the pressure, we know that the stream is more or less disturbed by eddies. When the need for this control became evident, we rebuilt Tubes A to L, and in each case measured the outflow per 60 seconds under the pressures named. In not one of these cases, as the charts will show, were the outflows proportional to the pressures employed. We therefore modified the apparatus so as to obtain steady streams. Three courses were open to us.

The steadiness or unsteadiness of such streams is determined by three factors: the size of the tube, the velocity of the stream, and

the viscosity of the liquid. A given liquid will flow steadily through a given tube, provided the velocity be not too great; a given liquid will flow steadily at a given velocity provided the tube be not too large; in a given tube, at a given velocity, one liquid will flow steadily, whereas a less viscous one will be thrown into eddies. Steadiness demands that the result of these three factors shall not exceed a certain critical value. It was open to us, therefore, either to increase the viscosity of the liquid, to diminish the velocities by employing lower pressures, or to reduce the size of the tubes. We chose the latter course.

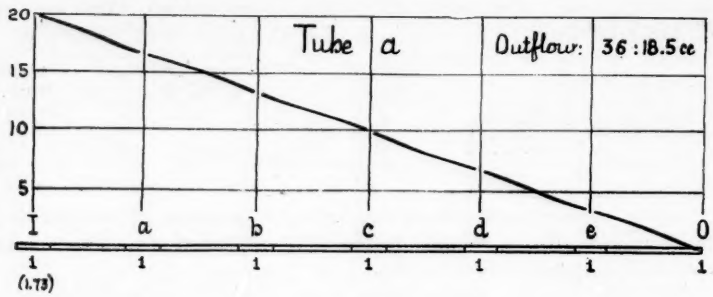

FIG. 11.

Tubes a, b, c (Figs. 11 and 12) were built to resemble the original Tubes A, B, C in all respects, except in the size of their cross-sections; these were smaller by one-half. The outflows from these smaller tubes were found to be very nearly proportional to the pressures employed; the streams may therefore be regarded as approximately steady. Here are the outflows in c.c. per minute from the larger and smaller tubes respectively:

	A	B	C	a	b	c
Under pressure 20 c.m.	134	152	80	36	42	20
„ „ 10 c.m.	74	81	43.5	18.5	21.5	10.5

Now compare the pressure-lines of the larger and smaller tubes respectively. Tubes A and a, although differing in size, give identical lines, for in each case the half-way pressure equals the mean of the end-pressures and there is no deflection. Tubes B and b give differing lines: in each case the line is deflected upwards in the middle region, but the deflection is smaller in the case of the smaller tube. Tubes C and c give downward deflections, and here again the smaller tube gives the smaller deflection. The following table

shows the differences, *plus* or *minus*, between the half-way pressures and the mean-pressures in percentages of the total fall :

	A	B	C	a	b	c
Under pressure 20 c.m.	0	+9	−10	0	+2.75	−1.5
„ „ 10 c.m.	0	+6	−6	0	+2	−1

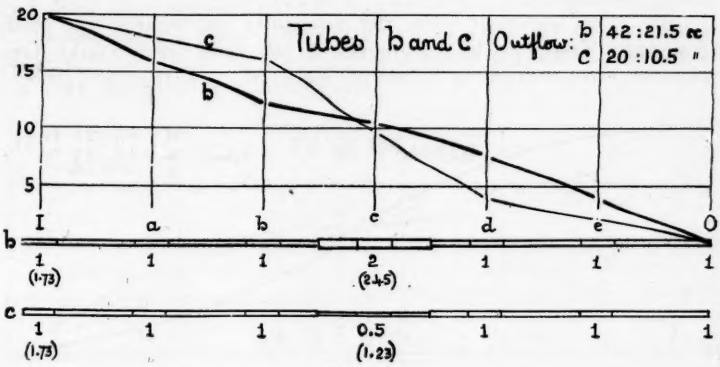

FIG. 12.

The smaller tubes, then, gave steadier streams and smaller deflections of the pressure-line. But it must not be assumed that the deflections were smaller only because the streams were steadier, for they were also slower. Lowering of velocity was associated with lessened deflection even in a stream which was practically steady. Thus in Tube b when the velocity was reduced approximately by one-half, the percentage-deflection fell from 2.75 to 2, and in Tube c, under the same circumstances it was reduced from −1·5 to −1. (Velocity in mm. per second is determined by dividing the outflow in cub. mm. per second by the cross-section in sq. mm.) Here are the end-velocities in mm. per second in the two sets of tubes respectively :—

	A	B	C	a	b	c
Under pressure 20 c.m.	465	528	313	250	292	139
„ „ 10 c.m.	257	281	170	128	149	73

Again, tubular systems that are alike as regards cross-section may differ greatly as regards the *amount and distribution of the resistance* they offer to the liquid flowing through them, and this may modify the excess of pressure at the half-way point to a very large extent. In considering the following examples the reader will remember that he can compare the amounts of resistance in different regions of a given tube by observing the varying slope of the pressure-line : *where the slope is steeper the resistance is greater.*

Tubes M N and O (Fig. 13) are alike as regards the total cross-sections of the channels through which the water flows. In each

case the cross-sections of the 5 segments of the tube are respectively as 1 2 4 2 1. On the other hand, they differ as regards the amount and distribution of the resistance they offer to the stream.

Tube M is fully open throughout, and the resistance as shown by the pressure-line (the thin line) is greatest in the end-segments, least in the middle.

Tube N is identical with the foregoing as regards the end-segments. The 3 middle segments, if left fully open, would have twice the cross-section of those of Tube M; but they are packed

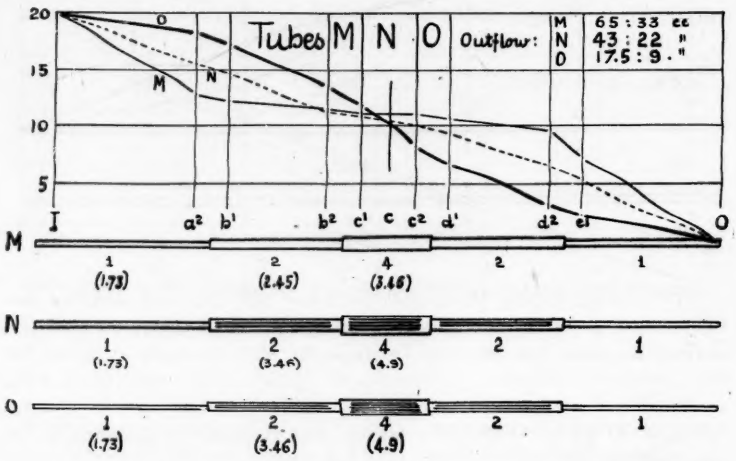

FIG. 13.

with straight wires in such a way as to reduce their effective lumen to equality with Tube M. The increased friction-surface given by *the wires adds to the resistance in these segments of the tube,* and the wires are so chosen as to number and diameter as to give nearly *equal resistance throughout the whole length of the tube—as shown* by the nearly uniform slope of the pressure-line (broken line).

Tube O is identical with Tube N as regards the containing tubes, but is packed with a larger number of smaller wires so chosen as to give the same effective lumen as *that of Tubes M and N, and at* the same time a greater resistance in the middle than at the ends—as shown by the pressure line (thick line).

Here then are three symmetrical systems all enlarging in the middle region, alike in their initial diameter and in the amount of their enlargement, but different as regards the amount and distribution of the resistance they offer to the stream. The point of interest is that while the half-way pressure exceeds the mean in each, the excess is smallest where the resistance in the middle region is

greatest: under a pressure of 20 cm. at *I* the excess in the three tubes M N and O was respectively 6.5, 2.5, and 0.75 per cent. of the total fall.

The difference is partly due, no doubt, to the lower velocities in the packed tubes: the velocities are proportionate to the outflows, and these were respectively 65, 43, and 17.5 c.m. in 60 seconds. Is it wholly due to this? Apparently not. To test the point we subjected each tube to three different pressures *viz.* 40, 20 and 10 cm. and obtained the following results:—

	Excess over mean in percentage of total fall.			Outflow.		
	M	N	O	M	N	O
under pressure 40 c.m.	7.75	4.6	0.37	118	79	34
„ „ 20 c.m.	6.5	2.5	0.75	65	43	17.5
„ „ 10 c.m.	5.	2.5	1.	33	22	9

It will be seen that Tube O under a pressure of 40 c.m. gave approximately the same outflow (same velocity) as Tube M under 10 c.m. The conditions in these tubes, therefore, were alike not only as regards total lumen but also as regards velocity, and yet the excess of pressure at the half-way point was in the one case only 0.37 per cent. of the total fall, while in the other it was 5.0 per cent. The amounts are small, and one cannot safely attach a precise value to the figures, but they appear to justify the following conclusion: ***A single tube and a branching system that are equal in aggregate cross-section, that enlarge equally in the middle region, and that transmit streams of equal velocity, do not give equal excess of pressure at the half-way point; the excess is smaller in the branching system.*** The large excess seen in the case of Tube L and others of that type is no criterion then for a minutely ramifying system.

Let us now turn to the blood-stream and consider it with regard to these same influences—first as to velocity and steadiness of flow, then as to distribution of resistance.

In certain regions the *velocity* of the blood-stream has been measured. In the arch of the aorta, it is probably about 300 mm. per second. In the capillaries of different parts, it has been found to be from 0.2 to 0.8 mm., say on the average 0.5 mm. per second, although the variations are probably greater than those here stated. In blood-vessels comparable in size with our artificial tubes, therefore, the velocity is probably lower than it was in our experiments.

As regards *turbulence*, it is important to note that the natural channels are built with special adaptations for the minimising of resistance at the points of branching, and are therefore more favourable to steady flow than are our crudely-built artificial systems. Moreover, blood is more viscous than water. Certainly, therefore,

the blood-streams are free from turbulence throughout the greater part of their course, and it seems probable, from certain experiments directed to the question,[2] that under normal conditions they are so even in the larger vessels. Turbulence involves loss of energy, and Nature in her living mechanisms is chary of such waste.

The elasticity of the arteries, be it noted, is an important factor in the avoidance of turbulence, for the blood-stream is driven by intermittent force. In our experimental apparatus, where the driving-force is constant, the substitution of elastic for rigid tubes would give no advantage in this respect, for under unvarying pressure such tubes would assume fixed dimensions. The difference, therefore, does not invalidate comparison as regards the point in question.

Lastly, the ***distribution of the resistance.*** It is easy to prove that in the vascular system of the body the resistance per unit of distance travelled—taking the multiple streams as one—increases from the aorta to the capillaries, and that the increase is very large. Two opposing influences are here at work: the lowering of the velocity of the blood, as it moves from the aorta to the capillaries, tends to diminish the resistance; the multiplication of channels tends to increase it. *Which influence preponderates?* We cannot experiment on a vast multitude of minute channels like those through which the blood is driven, but we can measure resistances in various simpler types of branching tube, and so arrive at a principle applicable to the more complex.

To compare resistances in different regions of a tubular system we have only to measure the fall of the pressure-line over equal lengths of the tube in the specified regions: ***the resistances are proportional to the amounts of fall.*** Let us first take the case of a tube which enlarges simply by increase of diameter, not by branching.

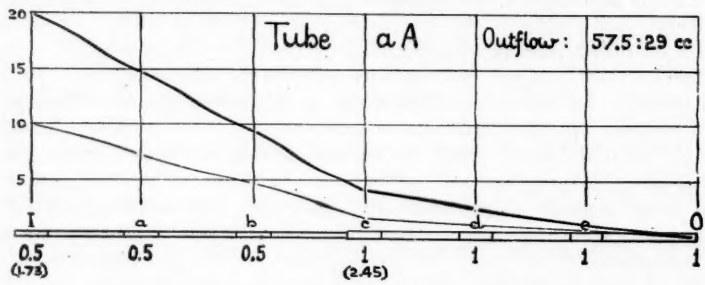

FIG. 14.

In Tube aA (Fig. 14) the cross-sections of the proximal and distal halves are as 1 to 2. Over the proximal half the pressure-line falls from 20 to 4 cm., over the distal half from 4 to 0; the falls are

therefore as 4 to 1, in other words, the distal fall is 20 per cent. of the total fall.

To realise the reason of this, note, firstly, that the two halves of the tube transmit the same quantity of water in a given time. Now,

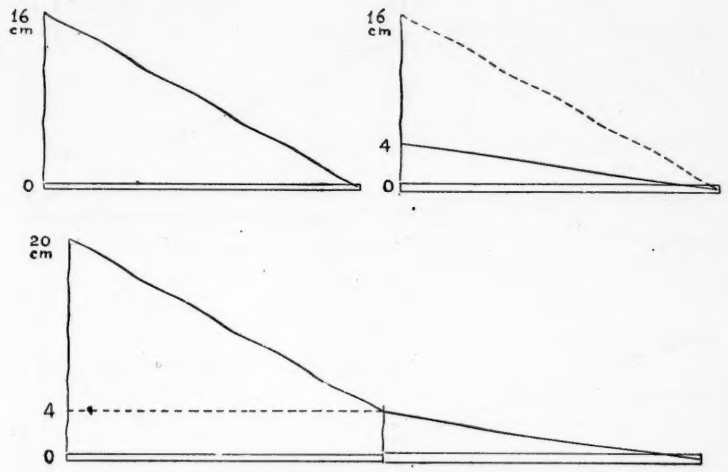

FIG. 15.

imagine the two halves to be disconnected and tested separately, each under an inlet pressure of 16 cm. (Fig. 15). Their pressure-lines would be identical, but the larger tube would transmit four times more water in a given time than the smaller, because it has double the capacity, and its stream has double the velocity. If the larger portion is to transmit the same quantity as the smaller, as it does in the entire tube, we must lower its inlet pressure from 16 to 4 cm. And if this same rate of flow is to be maintained when the two portions are reunited, we must raise the inlet-pressure of the entire tube from 16 to 20 cm. Then the stream, on reaching the half-way point, will still retain an unexpended lateral pressure of 4 cm., and this will carry it through the second half of the tube at the required velocity.

Now turn to branching tubes of several types. For the sake of accuracy it is well to take the pressures at points not too near to the bifurcations: to measure equal lengths of trunk and branches and to exclude the disturbances occurring at the points of bifurcation.

Tube P (Fig. 16) consists of a trunk and 2 equal-sized branches; the total cross-section of the branches equals that of the trunk. Over region *Ib* the pressure falls 4·3 cm.; over *d0* it falls 8·7 cm.—a ratio of approximately 1 to 2. In Tubes Q R S (Figs. 17, 18, 19)

measured in like manner, we find respectively ratios of approximately 1 to 1, 1 to 0·5, and 1 to 0·25. (The ratios actually given by the readings were 1 : 2·02, 1 : 1·04, 1 : 0·47, and 1 : 0·26; there were, no

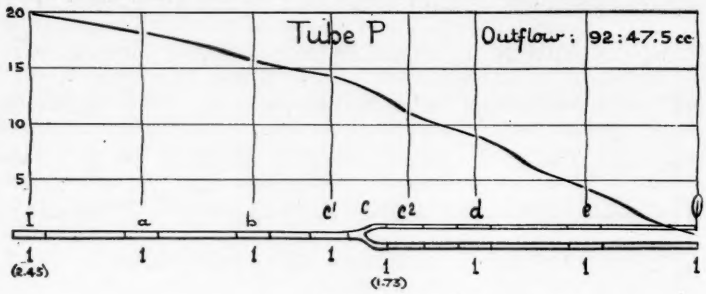

FIG. 16.

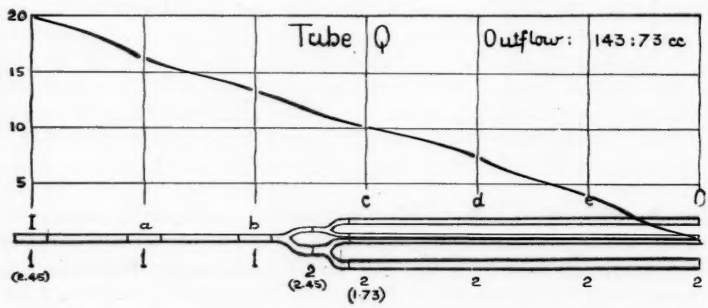

FIG. 17.

doubt, slight dimensional faults in the apparatus). These ratios represent the resistances respectively in equal lengths of trunk and branches, taking branches in the aggregate. From them the following rule may be deduced:—

To find the relative resistances in different regions of a tubular system in which companion branches are of equal size: Square the total cross-section in each region, and divide by the number of branches in that region; the products are inversely proportional to the resistances.

By means of this rule we can roughly calculate the relative resistances in equal lengths of the aorta and the capillary tract. Take the mean velocity in the arch of the aorta at 300 mm. per second, and that in the capillaries at 0.5 mm. per second; then, since velocity and cross-section in different regions of a given tubular system are inversely proportional, the cross-section of the aorta is to

that of the whole capillary tract as 0.5 to 300, or as 1 to 600. Again, take the cross-section of the aorta to be 500 sq. mm.; then that of the capillaries will be 500×600, *i.e.*, 300,000 sq. mm. Vierordt[3] puts it somewhat higher, but for our present purpose the exact figure is not important. Again, if we take the diameter of

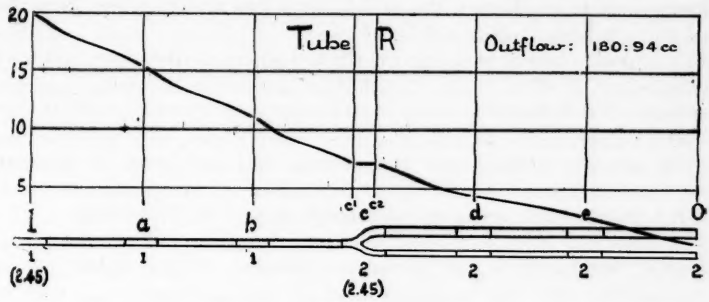

FIG. 18.

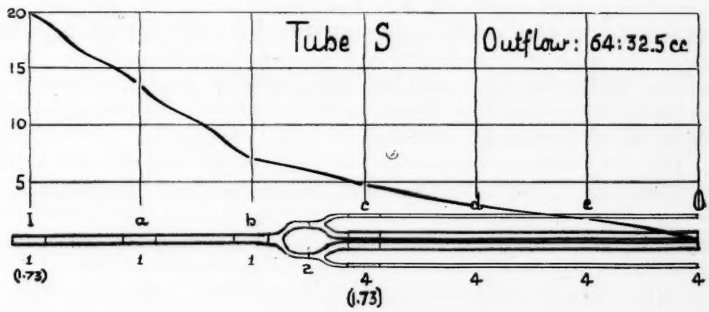

FIG. 19.

an average capillary to be 0·01 mm.; its cross-section will be 0.00007854 sq. mm.; then dividing the total cross-section of the capillaries by this figure we find that the total number of the capillaries is four thousand million. These then are the data:—

	Aorta.	Capillaries.
Ratio of cross-sections ...	1	600
Number of tubes	1	4,000,000,000

and according to the rule just given, the resistances in the aorta and capillaries respectively will be inversely as 1 squared divided by 1 (=1) to 600 squared divided by 4,000,000,000 (=approximately 0.0001); *i.e.*, as 1 to 10,000. The result is startling, but we must remember that the length of an average capillary is about 0.5 mm., and that we are comparing the resistance in the whole of

the capillaries with that in an equal length (0.5 mm.) of the aorta. The resistance in 10 cm. (4 inches) of the aorta would be to that in the capillary tract as 1 to 50. The calculation may involve considerable error by reason of faulty data, but there can be no doubt that while the cross-section of the blood-stream increases greatly from aorta to capillaries, the resistance it has to overcome increases in a much higher ratio still.

It appears then, that as regards the influences in question—velocity, steadiness of flow, and distribution of resistance—the vascular system of the body is more nearly comparable with tube 0 than with any other in our experimental series; hence we may infer that ***if the vascular system were symmetrical and horizontal the pressure in the capillaries would exceed the mean of the pressures in the main trunks by a very small percentage only of the total fall.***

Under the supposed conditions the pressure-line of the blood-stream would have the general character of the upper line in Figure 24. At the proximal end its gradient would at first be indistinguishable from a horizontal line; gradually, through progressive multiplication of the channels, it would slope more and more, and in the middle region it would be very steep. At the half-way point it would indicate a pressure slightly above the mean of the end-pressures. Beyond that point it would become progressively less and less steep, and near to the distal end would again be apparently horizontal.

But the vascular system of the body is *not symmetrical* in its proximal and distal halves. The veins—excepting the pulmonary veins—have everywhere a larger total cross-section than the corresponding arteries. Near to the heart, when distended by the normal pressures, they have about twice the cross-section of the arteries. In other regions the same ratio has been found, and it is said to

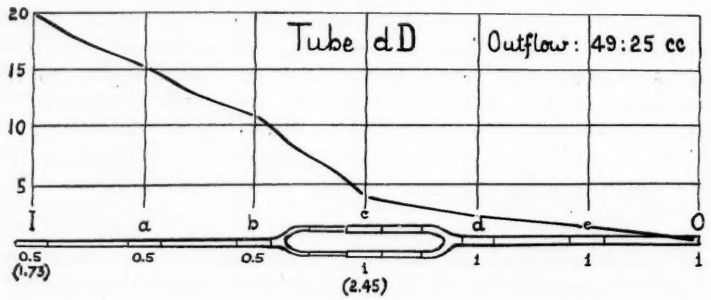

FIG. 20.

obtain throughout the system[1]. It would be rash to assume that this is strictly true, but let us provisionally assume it to be so and see how this particular asymmetry, apart from any other which

may be present, would affect the character of the pressure-line. We determined the question by experiment.

In the following tubes the cross-sections at corresponding points in the proximal and distal halves vary as 1 to 2—with the exception *of a few millimetres on each side of the half-way point where they* are equal. Since the two halves transmit the same amount of water *in a given time, the velocity in the proximal half is double that in* the distal. What percentage of the total fall of pressure belongs in *each case to the distal half ?*

In Tube aA (Fig. 14), which presents this asymmetry in its *simplest form, a pressure of 20 cm. at I gives 4 cm. at c,* while 10 cm. at *I* gives 2 cm. at *c* : the fall in the distal half is one-fifth, *or 20 per cent., of the total fall.*

Tube dD (Fig. 20), like the preceding one, was obtained from the *corresponding symmetrical tube by reducing the diameter of the* proximal half. Here again the distal fall is approximately 20 per *cent. (actually 20.5 per cent.) of the total fall.*

Tube G G (Fig. 21) was obtained from the symmetrical Tube G *by enlarging the distal half instead of by reducing the proximal ;* we could not in this case reduce the proximal, for the smallest *branches of the plexus were already as small as could be satis-*factorily employed. The velocity was much greater than in the *two previous cases, and the outflows show that the stream was not* entirely free from turbulence. The distal fall, nevertheless, is *exactly 20 per cent. of the total fall.*

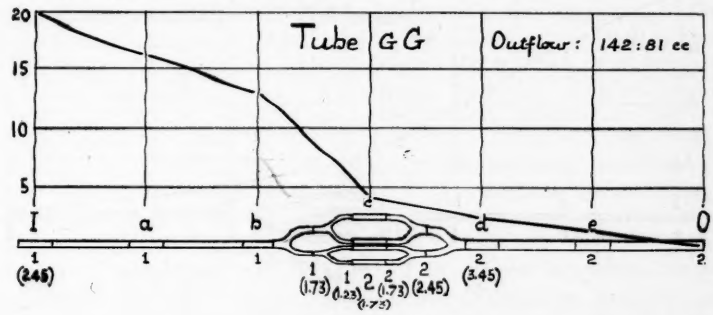

FIG. 21.

Now Tubes A, D, and G, of our symmetrical series, were those in which the cross-section of the channels was uniform throughout : the half-way pressure equalled the mean of the end-pressures ; in other words, the distal fall was one-half of the total fall. It is now evident that when such tubes, whether straight or branching, are rendered asymmetrical to the extent in question, the distal fall is reduced from 50 to 20 per cent. of the total fall.

It remains to ascertain what happens when tubes or systems *which enlarge in the middle region,* are modified in like manner. We have seen that symmetrical tubes of this kind give a distal fall

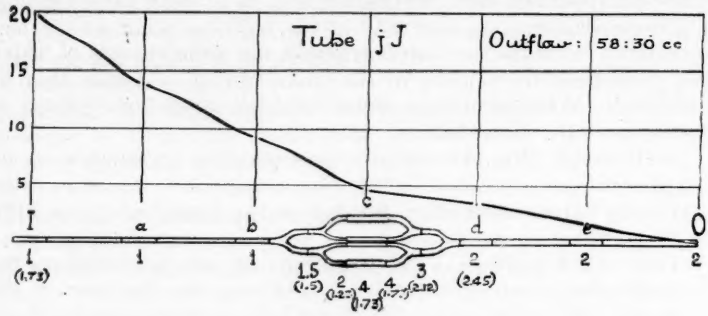

FIG. 22.

in excess of 50 per cent. of the total, and that the excess is smallest when the conditions of velocity, etc., most nearly resemble those of the blood-stream. We may expect that in the corresponding asymmetrical tubes the distal fall will bear a similar relation to 20 per cent. of the total fall; and this proves to be the case.

Tube j J (Fig. 22) shows a distal fall of 22·5 per cent, as compared with 53·5 given by the corresponding symmetrical Tube J.

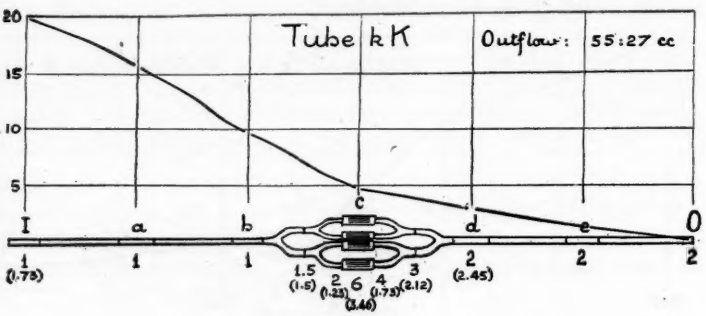

FIG. 23.

Tube k K (Fig. 23) shows 23·5 per cent. as against 55 per cent. given by Tube K.

To modify Tube O in the same manner was hardly possible, but in view of the foregoing results we may safely assume that since the symmetrical form gives a distal fall of slightly more than 50 per cent., a corresponding asymmetrical tube would give one of slightly more than 20 per cent.

We arrive then at the following conclusion:—*If the vascular*

system of the body were horizontal, and if the veins had everywhere twice the cross-section of the corresponding arteries but were equal to them in number and distribution, the fall of pressure in the venous half of the system would be approximately one-fifth of the total fall. A pressure-line obtained from such a system would bear a general resemblance to the lower line in Figure 24. The question is how

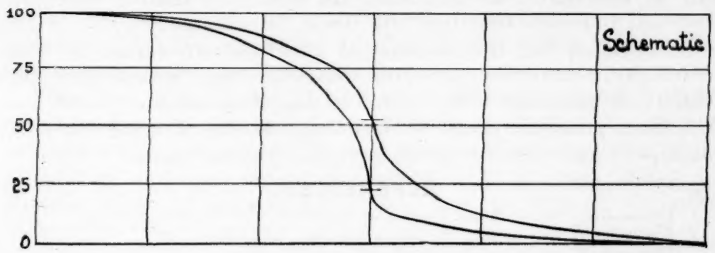

FIG. 24.

far this schematic line differs from the line or lines which the actual blood-stream would give. What sources of fallacy have we disregarded?

In the first place it is clear that no one line can be true for all the different paths that the blood may take in travelling from the left ventricle to the right auricle. At any given time the total fall of pressure will be the same for all paths, because the end pressures are the same, but the length, and consequently the steepness, of the pressure line will vary inversely with the length of the path taken.

In the second place we have calculated the resistances in the two halves of the system on the assumption that the veins are equal to the arteries in number and distribution, whereas in fact, a single artery is often served by two veins or more. Now this multiplying of venous channels must alter the resistance-ratio unless provision to the contrary is made by an alteration of the cross-sections. Thus, if the ratio of the cross-sections is everywhere 1 to 2, the resistances with a single vein will be as 4 to 1 as in Tube aA; with two veins they will be as 2 to 1 as in Tube R; with a larger number of veins they would be still nearer to equality, or equal, or even reversed. Veins are multiplied no doubt to safeguard the capillaries against over-distension when one or other vein is obstructed by pressure from without, and it is likely that where they are multiplied they are also increased in aggregate cross-section, so that they shall not offer increased resistance. Otherwise the venous fall in many blood-paths must be much greater than one-fifth of the total fall. But we do not know. Therefore our schematic line is open to question as regards the relative amount of pressure at the half-way point.

In any case this line, and indeed any other which might be devised, can be true only as an average. The pressures in the vascular system of the body change continually under vasomotor influence. Contraction of arterioles lowers the pressure in the corresponding capillaries. Hence, if the pressure in a given capillary area is one-fifth of the initial pressure under ordinary conditions, it will be less than one-fifth when the arterioles feeding that area contract, and more than one-fifth when they dilate.

It is evident that the problems of blood pressure cannot be fully solved by considering, however carefully, the physical principles which are involved. The data at our disposal are insufficient. Yet these principles must be constantly borne in mind when we attempt to appraise the results arrived at in other ways.

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(To be continued.)

A CONTRIBUTION TO THE PATHOLOGY OF CHOROIDAL MELANOMATA.

BY

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MELANOMATA of the choroid are of uncommon occurrence, and usually discovered by accident during routine ophthalmoscopic examination.

It is therefore only by some fortuitous chance that a specimen, which has been examined ophthalmoscopically during life, is obtained for microscopic examination.

In Volume XIX, Part iii, of the *Royal London Ophthalmic Hospital (Moorfields) Reports* were published four cases of this condition which I had examined clinically during life.

All four cases were discovered by accident, and none of them had given rise to symptoms.

A coloured drawing, by A. W. Head, of one of them is given in the *Reports*, and excellently depicts the ophthalmoscopic characters of these growths.

In one of the cases I was able, owing to the death of the patient from myasthenia gravis, to obtain the specimen, and microphotographs of both bleached and unbleached sections of this tumour are included.

It is pointed out in that paper that the ophthalmoscopic appearances of this last specimen differed in two particulars from the appearances of the three remaining cases, and I expressed some doubt as to whether this case was properly classed as a melanoma, and whether it might not in the course of time have manifested malignant characters had the patient lived.

A very complete *post-mortem* examination was made by Dr. T. H. G. Shore, but no evidence of dissemination was found, although specially looked for; nor did sections of the growth show any unequivocal signs of malignancy.

The two particulars in which this specimen differed from the other three when seen with the ophthalmoscope were: (1) a number of vesicle-like spots were present scattered over the area of the growth, but nowhere else in the fundus; (2) the edge lacked the slightly feathered appearance which was present in the other cases.

A consideration of cases published by Nettleship and de Schweinitz and Shumway lends rather strong support to Nettleship's suggestion, namely, that the presence of stippling or irregular pigmentation over the area of the tumour may indicate that it is actively growing.

I have thought the present case worth publishing because I was able to examine it ophthalmoscopically on three occasions during life, and it was in every essential precisely similar to the first three of the former cases, and to the coloured plate which is included with them, *i.e.*, it had what I take to be the typical ophthalmoscopic appearances of a choroidal melanoma, without the modifications which were present in the other specimens which I obtained.

The following is an abstract from my former paper of the ophthalmoscopic characters of these growths:

"In size they varied from about one-half the area of the disc to about four times its area."

"They were roughly circular or oval in outline."

"The edges were everywhere quite definite without being quite hard and sharp; there was no shading off into the surrounding fundus, nor was there any light fringe or evidence of pigmentary disturbance at the edge."

"They were of quite homogeneous appearance, and the choroidal pattern, although plainly seen around, was not seen over the area of the growths."

"In colour they were exactly that of blue ointment, differing from each other only in their density."

"All were single and close to the papilla."

"They were all discovered by chance; none of them having given rise to symptoms."

"During the time the patients were under observation (6 weeks,

5½ months, 5½ months, 10 days) there was no change in the appearances."

"There was no abnormal pigmentation of the eyes discoverable, on external examination."

As already stated, the foregoing description is accurate in every essential for the present specimen.

There was no irregularity of pigmentation discernible, nor stippling or other change over the area of the tumour, the edges of which were slightly feathered and not hard or sharp.

The patient, a man, aged 53, was under the care of Mr. W. H. H. Jessop, to whom I am indebted for permission to publish the case.

The man attended on account of failing sight, and was found to have well-marked papillœdema. A diagnosis of cerebral neoplasm was made, and a decompression operation was performed by Mr. L. B. Rawling.

Previous to the operation, the tumour in the choroid was somewhat obscured, owing to the extension of the œdema of the papilla into the retina, where it overlaid the growth.

With the relief of the intra-cranial pressure, the œdema subsided considerably; and on two subsequent examinations, a clear view was obtained.

The patient died two weeks after the operation, and a *post-mortem* examination was made by Mr. A. L. Moreton, of whose full notes the following is a short abstract:

J. C. *Post-mortem examination*, Dec. 20th, 1915.

"A tumour was found lying in relation with the sylvian point on the left side.

It was oval in outline and measured three inches by two.

It was perfectly circumscribed, had an imperfect capsule, and was adherent to the overlying meninges.

It compressed and displaced the neighbouring portions of the frontal, temporo-sphenoidal, and parietal lobes.

It could be shelled out from the depression which it had made in the brain."

Description of Tumour.

I removed the eyeball entire. It was embedded in celloidin, and sections were planned to include the optic disc (showing papillœdema) and the growth (Fig. 1).

Some sections were immediately stained with hæmatoxylin and eosin (Fig. 2), and others were so stained after bleaching with permanganate of potash and oxalic acid.

The tumour was about one disc's breadth distant from the edge of the papilla (Fig. 1).

It was roughly circular in outline, and conformed in every particular to the general description already given.

Its extreme breadth was 1·9 mm., and its thickness 0·4 mm.

FIG. 1.

Shows the general shape and position of the tumour and of a portion of the optic disc, which is in a condition of papillœdema.

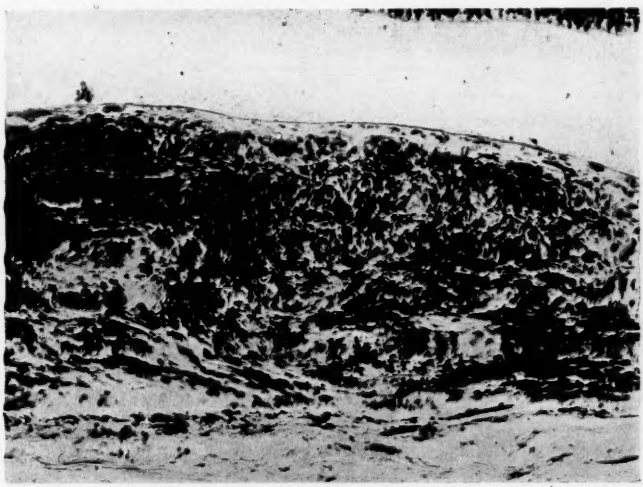

FIG. 2.

Shows the arrangement of the cells of the growth and the somewhat irregular distribution of the pigment.
The nature of the cells is not well shown.
The chorio-capillaris and the sclerotic are uninvolved.

It appeared to be formed in the more superficial layers of the choroid.

The overlying retina, pigment epithelium, and chorio-capillaris showed no change.

The sclerotic was not involved by the growth (Fig. 1).

The mass of the tumour was composed of very broadly spindle-shaped cells which showed a tendency in places to be arranged in coarse bundles (Fig. 2).

The nuclei were oval and well-formed; evidence of active mitosis was not observed.

Pigment was scattered throughout the growth in a somewhat uneven manner. The bulk of it was intra-cellular. I could not, however, be sure that none was extra-cellular.

In some places it was contained in globular cells; in other places it appeared to be contained in the long processes of branching cells.

The points in which this differed from the specimen previously reported were:—

(1) The pigmentation was less dense and less uniform.

(2) The arrangement of the cells was not quite so regular, and the large spheroidal cells, crowded with pigment, were much less conspicuous in this than in the former case.

There can, I think, be no doubt that this is an example of a melanoma of the choroid, benign in character, and probably congenital in origin.

THE REMOVAL OF FOREIGN BODIES BY MEANS OF A GIANT MAGNET.

BY

G. H. POOLEY, F.R.C.S.

SHEFFIELD.

IN my earlier work with the giant magnet, I followed the *technique of Haab*. As my own experience has led me to modify very considerably the views I then held, and as I am convinced that I *now get better results* since the change in *technique*, I venture briefly to outline my views and my practice, giving my reasons.

Haab assumes that most foreign bodies are spindle-shaped (melon seed) and smooth. My experience is that they are more frequently *irregularly triangular flakes with sharp angles*, and that they are much inclined to turn broadside on when they meet any resistance. *Most of the foreign bodies I have to deal with are from steel works*, and are fresh from the fire and nearly aseptic.

When the foreign bodies are situated in or behind the lens my rules are:

1. Do not make any attempts *to remove the foreign body before* its situation has been carefully localized. Three or four days' wait makes no difference to the result *I have removed some foreign* bodies after twenty years, others after ten years, and many in the second and third week, and later, with excellent results.

2. Do not use a trial pull.
3. Do not pull on the ciliary body.
4. The foreign body should be removed from the nearest point.
5. Do not try to remove a foreign body embedded in the choroid.

My present practice, as modified by the result of my experience, is as follows:—

1. If the lens is badly wounded, so that it must become opaque and swell up, and the foreign body is situated immediately behind it, to remove the lens and then to remove the foreign body by pulling it into the anterior chamber.

2. If the lens is not wounded, or only slightly wounded, or for other reasons it is not desirable to remove the lens, and the foreign body is situated behind the lens, to remove the foreign body by means of a conjunctival incision through the sclera behind the ciliary body, usually behind the insertion of the extrinsic muscles. The *technique* is.—An antero-posterior conjunctival incision is made about 3 mm. to one side of the site of the intended scleral incision and a temporary suture passed round the insertion of the nearest rectus muscle for fixation. A small parallel incision, about 4 mm. or 5 mm. long, is made in the sclera with a Graefe knife, and the point of a giant magnet placed upon or just introduced into this. If really necessary, a very small transverse section of the sclera may be added if the foreign body cannot be coaxed through the linear incision; the wound should close easily and not gape, for this reason the cross-section must be as small as will allow the foreign body to pass without bruising. The conjunctiva is sutured carefully at the end of the operation. I use alypin anæsthesia (retro-ocular injection) for all these cases.

Route No. 2 is the one which, I think, gives the best results. No. 1 is useful where the lens is going to give trouble very soon, as when there is a fairly large wound of the capsule in a man of over fifty years of age, whose lens will not easily absorb.

My reasons are as follows:—

1. A trial pull disturbs and clouds the vitreous unnecessarily and causes pain, which makes the patient less easy to control.

2. In all eye operations it is most essental to avoid bruising the tissues. The ciliary body is particularly intolerant of any bruising, if a foreign body has to be pulled through the suspensory ligament of the lens, the ciliary body is pulled on and the capsule of the lens is further damaged; the capsule may also be scratched; the iris is also bruised, and the inflammatory exudate which surrounds the foreign body, with any contained micro-organisms, is wiped off on the injured lens and bruised ciliary body, the result being:—

1. The eye is much more irritable and predisposed to attacks of cyclitis than is necessary.
2. The transparency of the lens is further imperilled.

3. Already damaged tissues are again bruised, and their resistance to infection is further lowered.

Where a scleral route is adopted, the advantages are:

1. The operation is easier to perform, for the magnet is nearer, and so more efficient, and there is no resistance to the passage of the foreign body. The vitreous is disturbed as little as possible.

2. The inflammatory exudate may even come out with the foreign body.

3. The ciliary segment is not bruised.

4. A sutured conjunctival wound has much greater freedom from late infection than a corneal wound.

The disadvantages of the scleral wound is:—impaction of the choroid, retina, and vitreous in the wound. This very rarely occurs; I have found it in one or two cases where I have had to excise the eye eventually.

I claim the following advantages:—

(1) A larger percentage of eyes is saved. (2) A better visual acuity in the saved eye. (3) A shorter period of convalescence after operation.

THE TECHNIQUE OF THE HAAB AND SMALL MAGNETS IN THE EXTRACTION OF INTRA-OCULAR FOREIGN BODIES.

BY

MAURICE H. WHITING, CAPTAIN R.A.M.C. (TEMP.) AND CHARLES GOULDEN, LIEUTENANT R.A.M.C. (TEMP.)

DURING the past twelve months we have dealt at the Hospital to which we are attached with a great number of perforating wounds of the eye.

Many of these eyes contained magnetic foreign bodies.

Some idea of the number of such cases will be gathered from the fact that in July, 1916, alone, there were 30 cases in which magnetic foreign bodies were removed from within the globe; in one day, 5 such cases were operated upon, and more recently, 13 in one week.

With such a large amount of material, it has been our endeavour to work out some systematic plan of treatment applicable to the various conditions found; and in the course of our operations we have elaborated many small points of *technique*, to overcome the varied difficulties encountered.

We are not aware that any detailed description of the use of the

Haab and small magnets in combination has been published, and it is the object of this paper to attempt to supply that deficiency.

The methods used are, in the main, an elaboration of those we have always used at Moorfields, and later (by one of us) at Oldham.

Cases of magnetic foreign bodies within the globe are comparatively rare in civil life, and any one operator, with few exceptions, does not deal with a great number in a single year. For instance, at Moorfields there were, between 1901 and 1905 inclusive, but 118 cases, although we are aware that this number has been exceeded in recent years, and that such cases must be more frequent in manufacturing areas where there are many iron and steel industries.

General principles of method adopted.—The wound of entry made by the foreign body, be it corneal or scleral, is disregarded from the point of view of extraction, unless there be a large unhealed wound in the cornea or sclera. Such a wound indicates the presence of a large foreign body in the vitreous, which it would be hazardous to remove by any other path. In any case these eyes are so severely damaged that there is but little chance of saving them.

The method we adopt is to draw the foreign body forward through the suspensory ligament of the lens into the posterior chamber, and then through the pupil into the anterior chamber. This operation is performed with the Haab magnet.

The foreign body is then removed from the anterior chamber, through a suitable corneal incision, by means of the small magnet.

The alternative to this general method is to remove the foreign body, after localization by X-rays, through the original scleral wound, or an enlargement of it, or through a suitably placed puncture in the sclera. In France, where a considerable number of the foreign bodies are non-magnetic, this would entail in many cases an unnecessary opening in the eye.

In a paper published by one of us in the *Royal London Ophthalmic Hospital Reports*, Vol. XVII, Part ii, it was shown that the after-results in civil cases treated by this method, were not so good as those in which the foreign body was removed *via* the pupil and anterior chamber.

The assistance given by an X-ray localization is by no means essential to successful treatment; if the localization is likely to involve more than two or three hours' delay, it should be omitted.

Description of apparatus employed.—The giant magnet we use is the most recent type designed by Professor Haab, and supplied from Zurich. It is hooded, actuated by a pedal, and has no rheostat. It is fitted with a chin rest, which we have removed, as we consider it hampers movement of the patient's head. Of the various terminals supplied, we use only the medium sharp-pointed short one, which gives a maximum of power with a minimum obstruction to view. Variation of power, when required, is obtained by advancing

the eye to or withdrawing the latter from the point of the magnet. The terminal is sterilized by boiling before use. The small magnet is one supplied by Messrs. Weiss, weighing about half a pound, and worked from a 3 or 4 cell accumulator. The terminal is about 1 inch long, of soft iron, originally cylindrical, but hammered, so as to become oval in section, and tapered like a screwdriver, and afterwards polished. This is sterilized by boiling before use, and the body of the magnet is wrapped in sterile gauze.

The corneal section is made with a straight keratome, 10 mm. from base to apex and 8 mm. in its broadest part. This enables one to make the section sufficiently large by an onward thrust without lateral movement. The importance of this will be seen later on.

Lang's solid blade speculum, fixation forceps (2 teeth into 3), Lang's double-curved iris forceps, de Wecker's scissors, and iris repositor complete the outfit.

When it is found necessary to wash out the anterior chamber, we use an undine with 3 feet of rubber tubing and a flattened silver nozzle.

For illuminating the eye in the various steps of the operation, we have found Curry and Paxton's operating lamp with Nernst burner most useful.

Preparation of patient for operation.—The patient, if possible, should be prepared as for a general anæsthetic, by having the bowels and bladder emptied and no food given for 3 or 4 hours beforehand. The face and lids should be cleansed with a simple lotion, such as saline or boric solution. It is most important to have the pupil well dilated with atropine; a sterile pad is then applied. In some cases it may not be possible to fulfil all these conditions, when operative treatment is urgently required, but the pupil ***must be dilated.***

Immediately before operation, two applications of 2 per cent. cocain are made to each eye, followed by one of adrenalin and one of 5 per cent. cocain to the injured eye. These should be spread over a period of about 5 minutes.

The lids are then wiped free from moisture, to enable a firm hold to be obtained by the surgeon's fingers.

Technique of the Haab Magnet.

1. *Position of patient.*—(a) *If the patient can sit up.*—The patient is seated on a chair of ordinary height with a back. The height of the patient is regulated with cushions until the eye is on a level slightly above that of the magnet point. The chair is drawn up as closely as possible to the magnet, the patient folds his arms and rests the forearms on the shelf attached to the magnet pillar (Fig. 1). This movement must be regulated by the surgeon, so as to avoid injury to the eye by bumping it against the magnet.

(b) *If injuries or general condition prevent the patient sitting up.*—This contingency is extremely unlikely in civil life, but has been met with frequently in war casualties.

The stretcher, with the patient on it, is placed on the operating table and the magnet is brought as close as possible to the head of the table, on the left side. The head-end of the stretcher is then moved laterally towards the magnet, so that one of the runners rests upon the arm shelf attached to the magnet pillar. The head of the

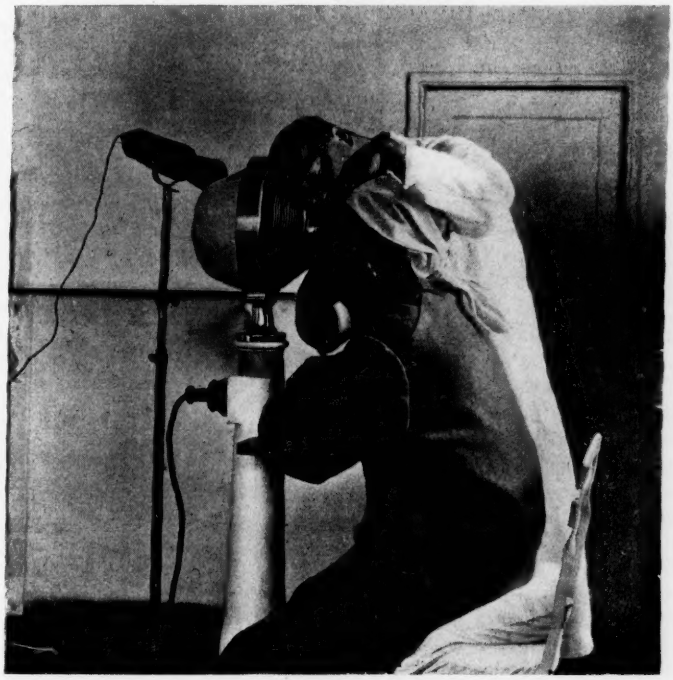

FIGURE 1.—Showing the general disposition of patient, operator, magnet, and light.

patient is elevated, by placing pillows under his head and shoulders, until he is in a semi-recumbent position, with the level of the injured eye a little above that of the magnet point. The head is then turned to face the magnet.

We always work with the magnet on the left side of the patient, irrespective of which eye is injured.

2. *Position of Surgeon.*—The surgeon stands on the right side of the seated patient with his left foot and left shoulder somewhat behind the patient and his right foot and right shoulder slightly in advance.

He rests the back of the patient's head in the hollow formed by the flexed elbow of the operator, supporting the head chiefly with the upper arm. This restrains any sudden movement of the head backwards, and enables the surgeon to bring the head of a nervous patient forward without undue effort.

FIGURE 2.—Showing the position when the magnet is first applied. Note the position of the hands of the operator, and the tilt of the patient's head.

(a) *Surgeon's hands.*—The palm of the left hand is placed on the forehead of the patient above the injured eye; the forefinger retracts the upper eyelid and retains it in position by pressure against the upper margin of the orbit. This, also, by lifting the eyebrow controls the most powerful part of the orbicularis and corrugator supercilii muscles. The other fingers should remain outstretched and placed on the bevelled core of the magnet, so as to regulate the distance of the eye from the magnet and to prevent pressure of the magnet point upon the globe. The thumb of the left hand remains on the forehead of the patient.

The fingers of the right hand grasp the lower jaw below, while the outstretched thumb retracts the lower eyelid, pressing against the lower margin of the orbit. The distal joint of the thumb is slightly flexed and the projection of this joint may be used to regulate further the distance of the eye from the magnet by contact with the bevelled core.

We know of no other grasp of the patient's head which gives such control and precision of movement. We have tried the method of standing behind the magnet and drawing the patient's head towards the point as illustrated in Haab's *Atlas of Ophthalmic Surgery* and have found it less satisfactory.

(b) *Position of Surgeon's head.*—The head should be inclined to his right shoulder, so that he views the patient's eye from the front as well as laterally and at the same time does not obstruct the light from the operating lamp. From this position any movement of the iris and often of the foreign body advancing through the vitreous can be observed.

3. *Position of operating lamp.*—The lamp is placed behind the magnet and on the patient's right side on the level of the magnet point. The beam of light is directed on the injured eye parallel to the bevel of the magnet core. The distance is regulated, so as to get the greatest concentration of light. The question of illumination is important, since a good light enables the surgeon to detect at once any movement of the iris.

(4) *Manipulation of the patient's head.*—The patient's head should not be advanced erect and facing directly forward to the magnet; if this be done, it will be found that the nose, to an extent dependent on its size, will come into contact with the bevelled core, and will prevent the head being advanced to the required position. Instead, the chin should be elevated, the head inclined slightly towards the same shoulder as the injured eye and rotated towards the opposite shoulder. Thus, in the case of a right eye, the head is tilted back, inclined to the right shoulder and rotated towards the left. The patient is instructed to keep both eyes widely open, to look at the magnet point, and to allow the surgeon to move his head freely in any direction. The head is then advanced until the magnet point comes into contact with the cornea just above its centre.

(5) *Operation upon patient lying down.*—In the cases which the general condition or injuries of the patient necessitate the recumbent position, or in which the operation with the Haab proves to be so painful that a general anæsthetic is required for its completion, the surgeon stands above the patient's head. The upper eyelid is retracted with the forefinger of the left hand and the lower eyelid with the forefinger or thumb of the right hand, the head and face being grasped between the two palms.

If the patient is under an anæsthetic and the whole weight of the

head has to be supported, we have found it convenient to insert a Clarke's wire speculum between the eyelids. The pedal of the magnet has to be worked by the assistant at the direction of the operator.

The operating lamp in these circumstances is adjusted, so that the projector is over the patient's abdomen and the beam of light shines down on to the patient's face. It requires some care to secure the best illumination.

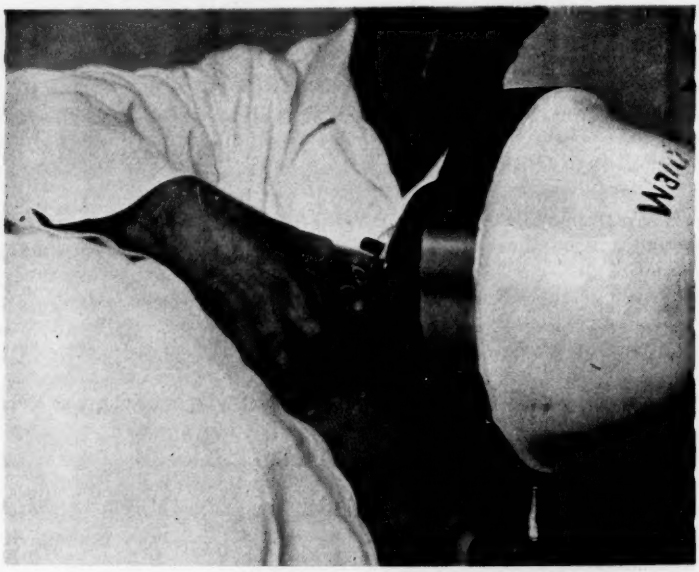

FIGURE 3.—Arrangement of the recumbent patient for operation upon the right eye. The position for operating on the left eye is obtained by raising or rotating the patient's head.

The full strength of the current is switched on by depressing the pedal. It is important that at this moment the magnet point should actually be in contact with the cornea slightly above its centre. It is surprising how much power is lost if there is a space of only a few millimetres between the cornea and the point of the magnet.

The reason for this relative position of eye and magnet will be readily understood when we consider the forces acting on the foreign body, namely, the vertical pull of gravity and the horizontal pull of the magnet. The foreign body will follow the resultant of these two forces, and travel obliquely downwards instead of horizontally

forwards. This is partly the reason why most foreign bodies present behind the lower part of the iris, also X-ray localisations show that in the majority of cases foreign bodies after penetrating the globe, sink to the lower part of the vitreous chamber.

The object of the sudden application of the full current is to disengage the foreign body from its bed (if it is resting on the retina),

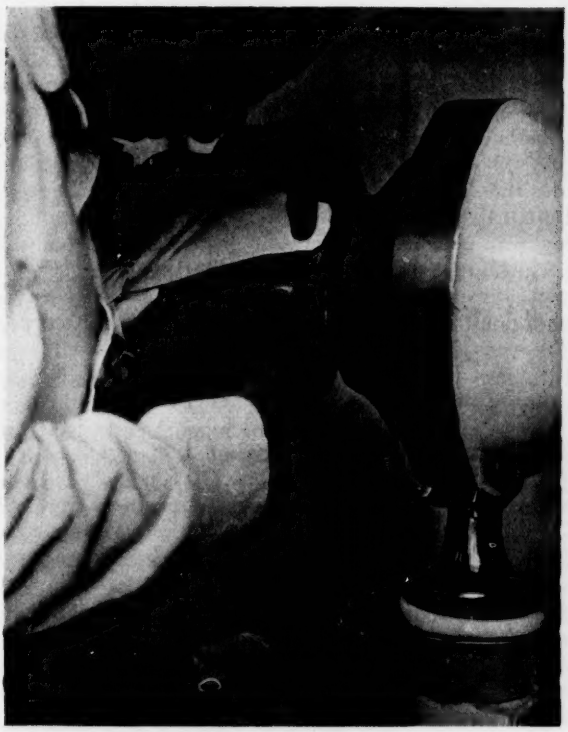

FIGURE 4.—Showing the position of applying the magnet for drawing the foreign body through the pupil after it has presented behind the iris below.

and to make it pass forward through the vitreous to the posterior surface of the lens as nearly as possible in the horizontal plane.

We have observed on several occasions foreign bodies advancing through the vitreous until they come into contact with the posterior surface of the lens, and then, slipping round the edge of the lens, suddenly appear quite free in the anterior chamber. This is the ideal result.

If the force be gradually applied, either by the use of a rheostat, or by starting with the eye at some distance and gradually advancing the head until the cornea comes into contact with the magnet point, three dangers will be incurred, namely:—the foreign body may be (1) dragged along the retina, (2) forced into the ciliary body, or (3) become entangled in the root of the iris. Usually, the foreign body shows its presence in the posterior chamber by pushing the iris before it.

When the foreign body presses on the iris, the patient experiences pain, and may state that he feels as if something were dragging on the eye. It is most important to notice the exact moment and position at which the bulging of the iris occurs; the moment, because the current must be cut off at once, to avoid entangling the foreign body in the substance of the iris, and the position, as this determines the subsequent manœuvres adopted to bring the foreign body through the pupil into the anterior chamber.

A very common position at which the foreign body presents itself is below. In such a case, after shutting off the current, the patient is told to look down, the head is tilted slightly forward, and the magnet point applied to the upper margin of the cornea. The current is then switched on again, and the foreign body slips forward through the pupil to the posterior surface of the cornea. The current is maintained, the head slightly withdrawn, and the patient told to look upwards until the magnet point is at the lowest part of the limbus.

The foreign body is thus drawn into the bottom of the angle of the anterior chamber, the most suitable position from which to remove it with the small magnet.

The above is a description of the simplest case. At any stage in the operation, difficulties may be encountered:

(1) *Delay in the passage of the foreign body through the vitreous chamber.*—Delay is most common in those cases in which the foreign body has been in the eye two or more days before the attempt at removal, and in which, consequently, it may be more or less fixed by exudate. Foreign bodies not infrequently appear in the anterior chamber coated with the exudate that has formed round them.

Almost always when a magnetic foreign body is present in the eye, the patient experiences some sensation of dragging from the first moment of application of the magnet. Even if no dragging sensation be felt, when the magnet is applied to the centre of the cornea, a very small magnetic foreign body may be present, and an attempt should be made to elicit the sensation by applying the point of the magnet to the sclera as far back as possible, above, below, and laterally. If the sensation of dragging be produced, efforts to bring forward the foreign body must be persisted in for a considerable time. It is in these cases that the method employed by Haab

proves most useful, that of applying the force of the magnet in a series of jerks. The magnet is applied to the centre of the cornea, and the current rapidly switched on and off with the pedal, alternating this with a series of long pulls.

We have in some cases obtained ultimate success by persisting in this method for five or more minutes. It may be desirable to interrupt the attempt for some hours, if the magnet becomes overheated, in order to allow it to cool.

In obstinate cases, the foreign body may sometimes be loosened by applying the magnet to various points on the sclera, so as to pull the foreign body in various directions, and so to loosen it. In this way also a greater force may be exerted by placing the point closer to the foreign body. This manœuvre is similar to the loosening of a stake driven into the ground by lateral movements before removing it by a straight pull.

It may be noted that delay in the vitreous is much more likely to occur in those cases in which there is some element of infection.

The presence of infection in the eye frequently causes the formation of bands in the vitreous which are attached to the foreign body. It will then be found that the foreign body can be brought forward with the Haab magnet, but on breaking the current, it is drawn back again into the vitreous. In these cases, persistent attempts must be made to break the bands, or at all events to stretch them as much as possible, before proceeding to the second stage of removal with the small magnet. This should be done by varying the position of the eye and the patient's head, so as to cause the greatest possible amount of tension to be put on the bands when the magnet is applied.

(2) ***Entanglement of the foreign body in the iris.***—When a foreign body is drawn forward, it frequently becomes more or less entangled in the iris. This shows itself by movement of the affected part of the iris towards the magnet-point. Such cases require the greatest amount of care in manipulation. It is imperative to disentangle the foreign body and to bring it forward into the anterior chamber; since if this is not done, any attempt to remove the foreign body with the small magnet is almost certain to end in disaster. It is improper to try to pull the foreign body through the iris; this will only impact it in the tissue.

The foreign body having shown its presence in the posterior chamber by bulging the iris forward, the current must be cut off immediately. We will suppose again that the foreign body has presented below in the right eye. The head of the patient is bent forward, the chin inclined to the left shoulder, and the magnet-point applied to the limbus up and out, so that the line of its pull shall be as far as possible in the plane of the iris, with as little forward drag as possible. The patient is at the same time told to look down

and to the left. The current is then switched on, and after one or two attempts, the foreign body will probably be released and come forward. If this be not successful, it is generally possible to detach the foreign body from the iris by applying the magnet-point still further back on the sclera, so that the pull is actually behind the plane of the iris. Once the foreign body is detached, it can easily be brought forward into the anterior chamber.

Similar manœuvres may be adopted for foreign bodies presenting at other points, with an appropriate change of the relative positions of eye and magnet.

(3) *The presence of a small corneal or corneo-scleral wound with prolapse of iris.*—No attempt must be made to remove the foreign body through such a wound, or through any enlargement of that wound. The foreign body should be treated as indicated above and brought to rest as near the lower angle of the anterior chamber as possible. The subsequent treatment of such a condition will be described later.

(4) *The presence of a very large corneal wound.*—In these cases the presence of a large intra-ocular foreign body is indicated, and the chance of saving the eye is correspondingly slight. There is considerable danger that iris, ciliary body, lens, or vitreous may be dragged out in an attempt at removal of the foreign body. Any attempt with the Haab magnet must be begun very cautiously with the eye at some distance, and the effect closely observed.

At the first sign of the foreign body presenting behind the cornea all further attempts with the Haab must cease, and the foreign body should be removed with the small magnet—as a rule, through the corneal wound. The small magnet gives ample power and is much better under control.

(5) *The presence of an unhealed scleral wound.*—If the wound be *large*, the foreign body should be removed through this wound, with the same precautions as in the case of a large corneal wound, and the sclera be sutured. If the wound be *small*, the foreign body should be removed by way of the anterior chamber, as if no scleral wound existed. The wound in the sclera, made by a small foreign body, never gives sufficient room for the withdrawal of the foreign body with the magnet and consequently would have to be enlarged. Even were the hole sufficiently large, the chances of the foreign body engaging accurately in it are extremely slight. But in any case the conjunctiva, and, if necessary, the sclera, should be sutured carefully over the scleral wound after the foreign body has been removed.

The Technique of the Small Magnet in the Removal of the Foreign Body from the Anterior Chamber.

Having brought forward and deposited the foreign body in the lower angle of the anterior chamber, the next step is its removal

from the eye. As a rule, this should be done under a general anæsthetic, for the eyes are often red and tender; the only exceptions are those cases in which the eye is white and, in the surgeon's opinion, the patient will be amenable to operation under local anæsthesia.

The patient is placed upon the operating table with the head supported by a cylindrical sand bag, which is adjusted in a comfortable position in the nape of the neck. A great deal of the success of the operation depends upon the manner in which the anæsthetic is given. It is most important that the patient should be "well under," and that the breathing should be free and not laboured. After the patient has been anæsthetised, the conjunctival sac is gently irrigated with normal saline solution at a temperature of 100° F. For this purpose, the eyelids are everted, and special attention is paid to the lid-margins and to both canthi, as well as to the fornices.

The speculum is inserted, and a firm grasp of the conjunctiva and subconjunctival tissue is taken at, or slightly below, the horizontal meridian of the cornea just outside the limbus. The eye is rotated well downwards.

The corneal section is now made directly above, beginning at a point 3 mm. below the limbus: that is, about half way between the limbus and the centre of the cornea. The point of the blade is directed straight towards the foreign body, and the section is completed by an onward thrust without lateral movement. A section made in this way will be of a valvular description, and on withdrawal of the keratome, the lips of the wound will come together and prevent the escape of aqueous.

The size of the incision is determined by the dimensions of the foreign body, and it may be necessary to carry the point of the keratome down almost to the angle of the anterior chamber. Allowance must be made for the fact that the opening on the deep surface of the cornea is smaller than that on the superficial surface.

The keratome is withdrawn fairly rapidly, but without any jerk, and precisely in the plane of its insertion. At the same moment the grasp of the conjunctiva is released. Provided that the patient is well under the anæsthetic, and that the section is made exactly as described, it will be found that little or no aqueous is lost. This end will be still more certainly attained if the weight of the speculum be taken off the eye by the assistant. Without loss of time, the small magnet is taken, and the point of the terminal is directed outside the cornea, and immediately over the foreign body. In this way the foreign body is attracted to the posterior surface of the cornea; by bringing the terminal upwards, still close to the cornea, the foreign body is drawn along the posterior surface and into the corneal section. The terminal is depressed on to the wound, and the foreign body thus withdrawn. During the whole

manœuvre, if possible, the eye must not be touched with fixation forceps, or the aqueous will probably be lost. Any tendency of the iris to prolapse after the foreign body has been removed, is overcome by manipulation with the iris repositor.

In a certain number of cases, in spite of all care, the aqueous humour is completely lost. It is then impossible to withdraw the foreign body in the manner indicated above.

Two methods of dealing with the case are now open, the first of which is to fill the anterior chamber with normal saline solution, and then to remove the foreign body as before. This will be successful when the loss of aqueous is due to some cause which can be corrected, *e.g.*, to slight squeezing, owing to the patient not being sufficiently anæsthetised, or to the weight of the speculum pressing on the globe.

The second method is carried out as follows:—

The eye is firmly seized with the fixation forceps in the horizontal meridian, and rotated well downwards. The magnet terminal, with the current off, is introduced into the corneal section, and passed straight down into the angle of the anterior chamber until it comes into actual contact with the foreign body. The current is then switched on, and the foreign body gently removed. Any tendency of the foreign body to hitch on the lips of the wound may be overcome by rotating the flattened magnet point so as to separate the lips of the incision. It will sometimes be found that on passing the terminal down along the posterior surface of the cornea, the lower pupillary border of the iris is pushed in front of it, and the magnet point cannot be brought into contact with the foreign body. Any attempt at removal then will only entangle the foreign body in the iris. The point must be insinuated in front of the iris by withdrawing it slightly, and sweeping it laterally and downwards with a movement following the curve of the pupillary border. If by chance the foreign body should become entangled in the iris, the current must be switched off and the terminal placed in a more favourable position before a fresh attempt is made, otherwise the iris will be torn away at its root. In our experience, cases in which an iridodialysis has been thus caused do badly.

In the numerous cases we have treated in this manner we have never had to do an iridectomy for prolapse of iris from the corneal section, either at the time of operation or later. In one or two cases only has there been adhesion of the iris to the corneal wound. These adhesions were easily detached with Lang's twin knives.

The foregoing description applies to uncomplicated cases; various conditions may be present which make the operation more difficult:

(1) ***Complications due to the nature of the wound caused by the entrance of the foreign body.***

(a) Presence of a prolapse of iris.—The procedure for removal of

the foreign body is the same as that adopted in an uncomplicated case. After the foreign body has been removed, the prolapsed iris should be cut off in the usual way.

On no account should the iridectomy be performed first, and then an attempt made to remove the foreign body through the site of the prolapse or an enlargement thereof. If the wound extend past the limbus, it may be necessary to insert a conjunctival or scleral suture.

It may be noted that a wound of the sclera may have to be treated in the same way, and a prolapse of vitreous cut off. The presence of an unhealed wound makes the section more difficult, by reason of the lowered intra-ocular tension.

(b) The presence of a traumatic cataract.—If the foreign body can be seen in the lens, and the eye show no signs of infection, operation for removal of the foreign body should be deferred until such a time as the cataract is also ready for removal. If, however, the lens be considerably broken up, and coming forward into the anterior chamber, the foreign body should be brought forward with the Haab magnet and removed as described, and the operation completed by washing out as much soft lens matter as possible.

If the eye be infected, operation should be undertaken at once and the anterior chamber thoroughly irrigated with normal saline solution at a temperature of 100° F. We have had several very gratifying results from such procedure.

(2) *Complications due to infection of the eye.*

(a) Presence of vitreous bands.—In the cases referred to under the *technique* of the Haab magnet, when vitreous bands prevent the foreign body coming forward freely, and the attempts with the Haab magnet have failed to free the foreign body entirely, difficulty will be experienced with the small magnet. Application of the point of the small magnet outside the cornea will be ineffectual; the terminal must be introduced into the anterior chamber and the end placed as near as possible to the spot where the foreign body presented. The current is then turned on and an attempt made to free the foreign body by gentle traction and lateral movements. It may be necessary to assist the magnet with some non-magnetic instrument, such as an iris repositor.

(b) Cases with exudate in the anterior chamber or hypopyon.—The exudate, which often forms a cast of the anterior chamber, may come out with the foreign body, and in default of this, should be removed with iris forceps. After removal of the exudate, a rather illusory impression of the condition of the eye is produced by the clearing of the iris and pupil; but the subsequent course of such cases frequently proves disappointing.

If hypopyon be present, it should be removed by freely irrigating the anterior chamber with normal saline solution.

The operation in every case is completed by placing a piece of sterile 1 per cent. atropine ointment in the conjunctival sac, and applying a pad and bandage.

The after-treatment of these cases is conducted on general lines, namely: frequent hot bathing and the use of atropine ointment, together with complete rest in bed.

We wish to express our sincere thanks to Colonel W. T. Lister, C.M.G., A.M.S., for his kind advice and encouragement, and for his assistance with the illustrations; and also to Lt.-Colonel Sidgwick, R.A.M.C., for allowing us to put on record the experience we have gained at his Hospital.

THE RING MAGNET.*

BY

T. HARRISON BUTLER, M.D.OXON.

ASSISTANT SURGEON TO THE BIRMINGHAM AND MIDLAND EYE HOSPITAL.

UNTIL Professor Mellinger, of Basle, invented the ring magnet *(Innenpolmagnet)*, the giant magnets in use by ophthalmic surgeons were all modifications of the Haab pattern. These consist of a central core of soft iron, surrounded by a bobbin of insulated copper wire. The core is prolonged into a cone which terminates in a point.

All these instruments have great polar magnetic power, but, as the lines-of-force radiate in all directions, the power is concentrated at the immediate pole, and rapidly falls off as the distance increases—in fact, diminishes as the square of the distance.

The divergence of the lines-of-force can be graphically shown by attaching a bunch of keys or iron filings to the pole of the magnet.

This feature diminishes the value of a magnet of the orthodox type for removing fragments of steel from the interior of the eye, and explains why a hand magnet is unable to extract these bodies unless it is brought into almost immediate contact with them.

A field of sufficient saturation can be obtained by the use of a giant magnet, such as a Haab, Volkmann, Schlosser, or Rollet.

Professor Mellinger has met the difficulty in a more scientific manner.

It is well known that when an electric current flows round a

* A paper read before the MIDLAND OPHTHALMOLOGICAL SOCIETY on October 3rd, 1916. The new magnet in the operating theatre of the Birmingham and Midland Eye Hospital was shown to the Society, and the direction of the lines-of-force in the Haab and ring magnet was demonstrated by iron filings.

solenoid, a homogeneous magnetic field is generated, whose greatest saturation lies at the centre of the solenoid axis.

The lines-of-force lie parallel and do not diverge, as in the case of the ordinary magnet. In consequence, the tractive force is great along the central axis at right angles to the plane of the ring.

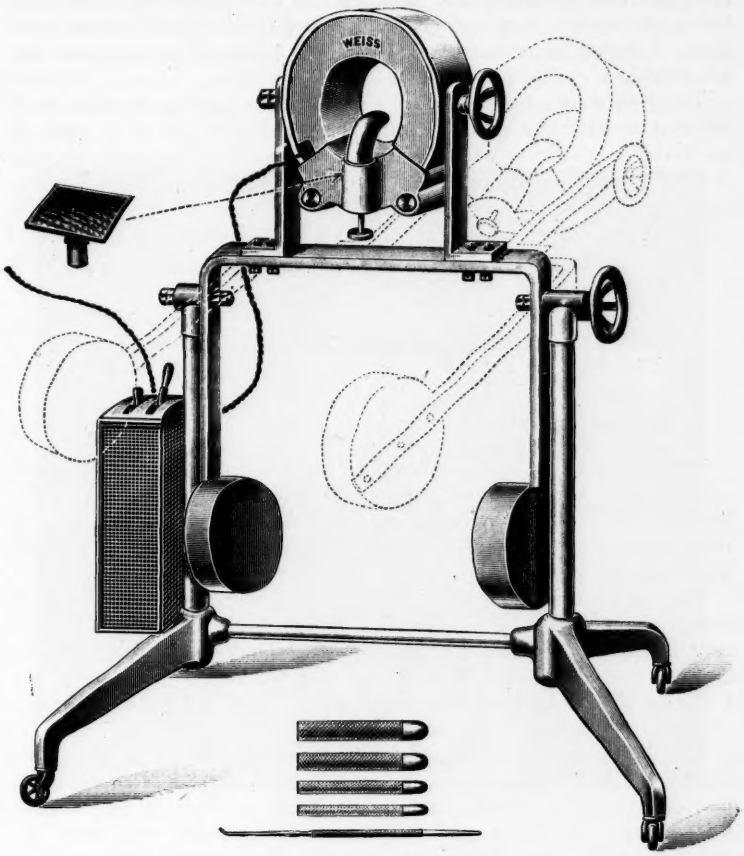

FIG. 1.

Outside this axis the force rapidly falls off, a fact which we shall emphasize when describing the method of employing the instrument.

The ring, or internal pole, magnet was originally made in Switzerland, but it is now manufactured in London by Messrs. Weiss, of Oxford Street.

The first in England was installed at Newcastle-on-Tyne, and after

informing myself that this had proved a success, I advised the Committee of the Coventry Hospital to procure one. I have used this instrument for the past four years, and have satisfied myself that it is thoroughly trustworthy.

We have just received a ring magnet at the Birmingham Eye Hospital, and, although we have used it only for a few weeks, we are satisfied that it is immensely superior to our Haab, which after doing duty for many years, was beginning to show signs of defective insulation.

The ring magnet consists of an oval ring just large enough to admit the patient's head. This is wound with about a mile of insulated copper wire, whose diameter varies according to the voltage of the current at command. This solenoid is covered with an insulating mass, and is fitted within a heavy iron case, which increases the density of the magnetic field. See Fig. 1.

FIG. 2.

The original model was mounted, like the Haab, upon a standard, and the patient was obliged to sit with his head in the ring. The disadvantages of this posture are obvious, and I have experienced them with my magnet at Coventry. I have heard of an accident due to this position.

The new model (Fig. 1) is a great improvement. The ring is balanced, and can be used either for a sitting subject, or placed round the head of a patient recumbent upon the operating table. This feature has proved to be so valuable that I have sent the Coventry Magnet to be remounted upon a balanced frame.

A switch and a rheostat form part of the new apparatus.

The magnet can be wound for any desired voltage between 100 and 250. If the town current be of the alternating type, a rotary converter must be fitted. There are fluid rectifiers on the market, but I am told by a practical electrical engineer that they are unsatisfactory. The Volkmann magnet used at the Hotel Dieu, at Paris, is supplied with a continuous current from a mercury vapour lamp rectifier.

A case of soft iron rods and a massive horn are supplied with the instrument.

I have had a small spatula made by Messrs. Weiss which can be inserted into the eye, and is a useful addition to the apparatus. This is shown in Fig. 2.

Experience with the spatula has shown that one tip should be bent over almost at a right angle.

I find that the magnet is balanced with the horn *in situ*. This is infrequently used, and is rather in the way when the instrument is employed upon a recumbent patient. Under these circumstances, without the horn, the magnet does not balance. I have suggested to Messrs. Weiss that they should fit the stand with adjustable balance weights, an improvement which they have adopted. The locking-screws are unsatisfactory, and have to be hove up very hard. This will be remedied in future by introducing a split locking-washer.

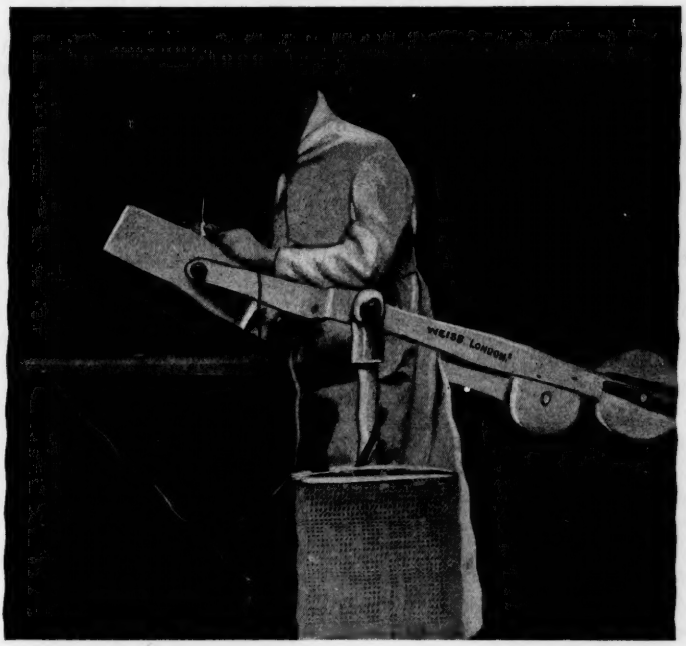

FIG. 3.

The tractive power of the magnet is enormous, and great care must be taken that the fragment is not dragged through the lens. The force, however, can be so perfectly graduated by the use of the rheostat and by the choice of rods, that there is no excuse for causing damage to the eye.

Watches must not be brought near the apparatus at any time. The residual magnetism is quite sufficient to magnetise the hair-spring. When in use, the magnet will saturate a watch and

actually stop it. I have twice had to have my watch demagnetised since I have had a ring magnet.

The patient is placed upon the table and his head is raised upon a small pillow. The ring is placed over him, and his head so adjusted that the injured eye lies in the centre of the solenoid (see Fig. 3).

He is now directed to fix an object in the ceiling, and warned that if he move his eye it may be seriously injured. A speculum is introduced, and the current turned on, with full use of the rheostat.

The smallest rod is first taken up and held firmly. The solenoid forcibly draws the rod toward its centre, hence the necessity for a secure grasp. For the same reason the wrist should rest upon the ring or upon the rest furnished with the magnet.

The rod is approached to the eye along the anterior-posterior axis of the globe, and carefully moved towards the cornea. The rheostat is gradually taken out of action, until the full current has been tried, using the small staff. This procedure is repeated with each rod in turn, always passing on to the next largest size. If no effect be produced, the horn is placed in position, and the magnet used as a Haab.

Generally the splinter appears behind the iris with one of the smaller rods. It is now coaxed into the anterior chamber.

The eye must be under the full action of atropine, otherwise the splinter may get impacted in the iris, and iridectomy will become necessary. This calamity can generally be avoided if the pupil be fully dilated before any attempt be made to extract the splinter.

When the foreign body is in the anterior chamber, the current is turned off, and an incision made with the keratome. It is now easy to remove the splinter. The current is turned on, the rheostat placed at "Weak Current," and the small spatula introduced. No hand magnet is necessary; the spatula is sufficient.

In cases where it is judged that it is wiser to extract through the sclera (and I think there are many such), an incision is made, or the wound enlarged; a suture is placed ready in the conjunctiva; and the spatula introduced. If the small spatula fail, the largest may succeed, as it did in the last magnet operation I performed. The tractive force which is exerted by the magnet is very much greater than any which can be obtained by a hand magnet, and in consequence we get more successes than we did with the older methods. The fragment will fly to the spatula from a much longer distance than it will to the Snell, and it is not so necessary to place the instrument almost upon the splinter.

For the same reason foreign bodies embedded in exudate are more likely to be dislodged by the greater force exerted.

If great care be taken to employ only the minimum force which

is necessary to remove these bodies, I believe that we shall, with our new magnet, save many eyes that would have been lost had we the Haab and the Snell alone at our command. But if undue force be used, we shall certainly have more detachments of the retina in cases where the fragment is encapsuled.

I cannot help feeling that these operations, which require great judgment and skill, should not be deputed to the house surgeons until they have proved that they are possessed of the necessary judgment and *technique*.

In the past I have used the Haab for every case of steel splinter in the eye where the ring magnet has failed. *In no single example has the Haab removed the foreign body under these conditions.*

I am sure that with the use of the spatulæ introduced into the eye, we shall be able to remove many pieces of steel which have failed to appear when the magnet has been used according to the classical Haab *technique*.

I would, in the case of a presumedly small spicule of steel, always first try to bring it round the lens, but if this method fail, and I am certain that there is a foreign magnetizable body in the eye, I shall generally make an incision in the sclera and attempt to remove it with the spatula.

We should never forget that there may be two or more splinters in the eye. I have lost one case of this type by overlooking a second fragment. To avoid this error, a second X-ray photograph should be taken when a foreign body has been extracted.

The advantages of the new model of the ring magnet in comparison with those of the Haab pattern are so great, that, in my opinion, the older instruments are completely outclassed.

They may be summarised as follows:—

(1) The operation can be performed upon a patient lying upon the table.

(2) There is no necessity to move him when the splinter has appeared in the anterior chamber. I have lost sight of the fragment in more than one case, and have been obliged to make the patient get up again, and place him before the magnet a second, or even a third, time.

(3) There is no necessity to use a hand magnet. As soon as the splinter is seen in the anterior chamber, the circuit is broken, the anterior chamber opened, and the spicule removed with the spatula.

(4) The power of the ring magnet at its centre is great, and is under absolute control.

(5) It is much easier to operate with the rods upon a motionless patient than to have to move his head this way and that before the Haab.

(6) A patient sitting before the Haab may experience pain, and move at the critical moment; he may even faint from the pain.

The only valid objection to the magnet is that the force is considerable only at the centre of the solenoid. In consequence, the eye must be kept in the centre. I have never found any difficulty in placing the eye in this situation and keeping it there.

I have succeeded in removing pieces of steel from the cornea which were difficult to extract with a needle, and shall make further experiments in this direction.

The two photographs in the text (Figs. 1 and 3) are from the new magnet at Birmingham.

Fig. 3 shows the ring placed too obliquely over the patient's head; it should be almost horizontal, resting gently upon the neck.

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ABSTRACTS.

I.—COLOUR INTERLACING AND PERIMETRY.

Walker, C. B.—Colour interlacing and perimetry. *Trans. American Ophth. Society,* Vol. XIV, Part ii, page 684, *1916.*

This paper which formed a thesis by **Walker,** of Boston, for membership in the Society, deals with some improved perimetrical methods devised by the author, and the results obtained by them in neurological cases in which there were changes in the optic discs of a nature suggesting increased intracranial pressure.

All surgeons who have paid attention to the difficult subject of perimetry, a subject very inadequately dealt with in the text-books, must have felt how unsatisfactory the results obtained by the ordinary recording perimeters are. For the rough measurement of the peripheral field for white, in the hurry inseparable from the

work of a large clinic, they may serve well enough; but for the accurate measurement of scotomata and colour fields, they are most untrustworthy.

Walker begins by discussing the difficulties of obtaining trustworthy results under three heads:—1. Psychologic; 2. Physical or physiologic; and 3. Mechanical.

1. Under the first heading he takes into account the personal equation due to the patient's intelligence and previous experience. Thus, highly educated persons may unconsciously take advantage of the percentage of chance, and also may judge colours entirely by their light intensity. This is facilitated by the fact that all colours pass through a threshold of various neutral tints before the true colour is appreciated. The threshold for blue is usually less sharp than that for red, while green has such an indefinite one as to render it of much less value in these examinations.

In order to reduce guessing of this type, it is of great importance to avoid anything like a definite sequence of presentation of the colour.

He goes on to state that for the best results the form field should be made a separate examination from the colour test, because it involves a different class of judgment, but, of course, all the colour readings on a particular radius should be taken as nearly at the same time as possible. The first few readings in both cases are apt to be wrong, and should be discarded. The reading for white is practically worthless, because of its very confusing threshold, varying through all the shades of grey. For this reason the patient is never allowed to say "white," but is forced to report first motion only. The rate of motion of the test discs is of considerable importance, and must be adapted to the intelligence and attention of the individual patient. The examiner, also, should be on his guard against letting the readings fit in with his preconceived idea of the field, as he may do unconsciously. In order to avoid this, the author prefers to take the field before making an ophthalmoscopic examination.

2. As regards *physical* conditions, Walker attaches great importance to making the patient comfortable. He himself has devised a suspension apparatus for the perimeter, but, if this is not available, advises the use of an adjustable perimetric table on which the patient can rest his arms while seated in a comfortable chair. In many cases he has found it necessary to allow numerous periods of rest during the examination. Severe headache or pain will cause great variations in the reading. Unfortunately, this group of cases includes often the ones that have choked discs and other evidences of increased intracranial pressure requiring prompt decompression, so that it is impossible to wait for the infrequent periods in which the headache is very slight. It is precisely this type of case that is likely to show colour interlacing due to the varying attention during

any one set of observations, thus making it necessary to take the average of more than one reading.

3. *Mechanical.*—The room in which the observations are made should be comfortably warm and free from noise and disturbance. Walker uses a room with large windows of northern exposure, and has the walls facing the windows darkened, and wears dark clothes and gloves. He has devised a method of artificial lighting by means of a circle of electric incandescent lamps behind the patient, of which an illustration is given.

He next gives what he believes to be the necessary requirements for accurate perimetric measurements from the mechanical point of view. These relate chiefly to the importance of being able to work from a blind area and to approach a scotoma either at right angles or tangentially, conditions the importance of which will be thoroughly appreciated by all who have worked with Bjerrum's methods. He lays stress on the importance of being able to change colours in the testing disc noiselessly and instantaneously, for which purpose he has devised a very ingenious carrier, illustrated in the text and previously described by him (*Archives of Ophth.*, Vol. XLII, No. 6, 1913). He also discusses various devices to maintain fixation in cases of defective central vision. One ingenious method of managing in a case of central scotoma seems worth drawing attention to, *i.e.*, the attaching of several spots of fixation on his pattern of perimeter at points found by several approximations to lie just on the periphery of the scotoma and directing the patient to keep all those spots in view while the peripheral field is being examined.

He mentions electric perimetry merely to condemn it as inaccurate and lengthened, owing to the difficulties connected with light and dark adaptation.

He illustrates his form of perimeter, which aims at obtaining the largest possible surface upon which to make measurements, and definitely rejects all means of mechanical recording. The method of construction consists in attaching to the ordinary perimeter a sheet of thin brass cut into a section of a sphere of 28·6 cm. radius. This surface is cut to extend 35 degrees about the centre in three quadrants, and 95 degrees in the remaining quadrant, with a lateral width sufficient to include three of the 30 degree lines radiating from the centre. The whole surface is marked by deep numbered lines, cut in the metal to correspond with the field chart, and it is attached to the perimeter by means of rollers, so that eccentric fixation may be obtained by displacement along the arc to the desired number of degrees. The position of the arc is set at any desired 30 degree angle and fixed in position by a spring catch. The eye is placed at 28·6 cm. from the centre, in order that the discs (a table of the sizes of which is given) may be recorded in visual angles directly

as indicated or in diameters. He says that in this way the field for the smaller visual angles can be measured with much greater ease and rapidity than by Bjerrum's method.

The rest of the paper is devoted to a summary of the results obtained and to an explanation of the results obtained by less accurate methods. Walker comes to the following conclusions:—

1. For the detection of early pressure effects on the optic tract, examination of the fields for the smallest visual angles gives the most reliable results.
2. Colour interlacing is not a reliable test for cerebral pressure.
3. Most of the colour interlacing found in the past in brain cases may be accounted for by a variety of variables largely psychological and physical.
4. Perimetry on semi-reclining patients by artificial illumination imitating daylight has been found practical.

At the end of the paper is given a series of tables of various cases with ophthalmoscopic signs of possible raised intracranial pressure in which colour interlacing was or was not present, taken from Professor Cushing's clinic.

The paper is a noteworthy contribution to a difficult subject, which has been rather neglected in this country.

We think the author does rather less than justice to Bjerrum's methods, especially in the simplified form described by Sym and Sinclair (*Obhthal. Review*, 1906, p. 145) and Duane (*Archives of Ophth.*, Vol. XLIII, No. 6, 1914), but his disc carrier is an addition of distinct value. E. E. H.

II.—THE MAGNET AND MAGNET OPERATIONS.

(1) **Alt, Adolf.—Magnet extraction of a piece of iron from the eye: avulsion of iris; glaucoma; enucleation.** *American Journal of Ophthalmology*, January, 1916.

(2) **Shahan, W. E.—Removal of steel from lens; non-formation of cataract.** *American Journal of Ophthalmology*, May, 1916.

(3) **Ohly, John H.—The electro-magnet and the magnet operation in ophthalmic surgery.** *Trans. Amer. Ophth. Society*, Vol. XIV, Part ii, 1916, p. 762.

(4) **Morax, V.—Notes on the prognosis and the technique of the extraction of intra-ocular magnetic chips. (Notes sur le pronostic et la technique de l'extraction des éclats magnétiques intra-oculaires.)** *Annales d'Oculistique*, T. CLIII, octobre, 1916.

(1) The description by **Alt**, of St. Louis, of the microscopic appearance of an eye which became glaucomatous after being badly

damaged by the forcible removal from the eye of a piece of metal, should be read in the original. It may be said here that the eye became glaucomatous, in spite of the complete tearing away of the iris, because "the compressed fibres of the ligamentum pectinatum were filled with, or covered with, a newly-formed connective tissue, which here and there was covered on the inner surface by a thick layer of pigment epithelial cells; in other places the foremost ciliary process was firmly attached to this newly-formed tissue. Schlemm's canal was obliterated in all the sections." ERNEST THOMSON.

(2) **Shahan,** of St. Louis, records an example of the type of case, which occurs occasionally and confounds the prognosis of the ophthalmic surgeon, where a penetrating injury of the lens results only in a localized opacity. In the present case a piece of metal entered the lens, from which it was extracted through the original corneal wound with the hand magnet. Eight months afterwards the visual acuity was 20/15. The "lens was clear except at former site of foreign body, where there is a linear scar in the anterior capsule and iris pigment and circumscribed clouding behind it. I have seen two other somewhat similar cases."

Most ophthalmic surgeons have had such cases now and again.

ERNEST THOMSON.

(3) This lengthened thesis by **Ohly,** of Brooklyn, was accepted for membership in the American Ophthalmological Society.

Its first eight pages are devoted to the history of magnetism and the electro-magnet. Ohly shows that the magnet was used in medicine nearly two thousand years ago. According to Hirschberg, the points of broken steel arrows were extracted by magnetic ore by Sucruta Ayuveda. In 1462 Brunschwyek advised the removal of iron splinters from the eye with a magnet, and in 1656 Fabry employed the same means for the removal of an iron foreign body from the cornea. In 1858 the English ophthalmic surgeon Dixon (*Ophth. Hosp. Reports*, 1858, I, p. 282) reported the successful extraction of a steel scissor blade from the vitreous by drawing it into such a position that it was removed by forceps through a scleral incision. The more modern work of McKeown (1874), Hirschberg (1875), Snell (1881), Gruening (1880), and many others receives due recognition. The giant magnets of Haab (1892), Mayweg (1902), Schloeser (1903), as well as the magnets of Volkmann (1902), Mellinger (1904), and Lancaster (1915) are briefly described.

The next few pages of the thesis are devoted to a consideration of the various methods employed to diagnose a foreign body within the eyeball. The credit of first using the magnetic needle for the detection of magnetic particles within the eye is given to Thomas R. Pooley (*New York Medical Journal*, 1902). Various forms of sideroscope are described. The author concludes that the X-rays are the most accurate means of detecting a foreign body in the eyeball,

which cannot be diagnosed by the usual methods. Localization is next touched upon, and the methods of Sweet, Mackenzie Davidson, Hullen, Holth, Dixon, and others receive attention.

The methods of removing foreign bodies from within the eyeball next claim Ohly's notice. In this matter he recognises that it is impossible to follow any general rule. The chief consideration is to select the plan which will cause the minimum amount of injury and avoid any entanglement of the foreign substance in the tissues of the iris or ciliary body. A description is given of the so-called "anterior" (Haab) and "posterior methods" (Hirschberg). Both have their successes and their failures. In 5 of the 10 cases reported by Ohly the posterior method was adopted. Under no circumstances should an attempt be made to extract a foreign body from the eyeball until its exact position has been ascertained. In order to avoid infection, Ohly makes a large conjunctival flap, and when the operation is finished, sutures it in such a way that none of the stitches are placed over or near the opening in the sclera. The sclera itself is not sutured. In making the incision, the conjunctival vessels afford good landmarks, and a sterile compass is a valuable aid. He usually makes a T-shaped incision, employing a Graefe knife for the purpose. Care is taken to avoid entering the vitreous to a depth of more than 1 mm. or 2 mm. The vertical part of the incision is 3mm. to 5mm. in length, while the horizontal part does not exceed 2mm. to 3mm. The lips of the incision being held apart, the tip of the magnet is introduced between them, and at the first attempt never thrust into the vitreous. If the foreign body does not appear (as it usually does when correctly located), smaller tips are used, but in none of his cases did he find it necessary to enter the vitreous to a greater depth than 2mm. or 3mm. Detachment of the retina as a result of the operation is due to (*a*) making too deep an incision, (*b*) entering the tip of the magnet deeply into the vitreous, or (*c*) moving the magnet about without due caution. When detachment occurs with proper care, Ohly assigns it to injury produced in the vitreous by the entrance of the foreign body. In one of the author's cases complete aniridia was produced on making an attempt to extract the foreign body through the original wound in the limbus. Ohly advises that the large magnet should be suspended by a counterweight, and that the current should be controlled by a foot switch.

Ohly's 10 cases may be briefly summarized as follows:—in 1 the foreign body was in the lens, and in 9 in the vitreous. In 8 of the last-named it was removed, and in 1, on account of faulty localization, it was not extracted, although both the anterior and the posterior routes were tried. One case, where the foreign body was removed through the original wound in the sclera, regained V. of 6/6, and 1, where it was extracted by the original wound in the limbus, had V. of fingers at 1 metre. One case where the

anterior method was adopted, had V. of fingers at 2 metres, and is still under observation. Of the 5 cases where extraction was by the posterior route, 2 had V. of 6/6; 1, V. of 6/9; 1, V. of 6/12; and 1, with choroidal disease and cataract, V. of moving objects.

There are 74 entries in the table of references with which the thesis concludes. S. S.

(4) The prognosis of the ocular wounds with the presence of a magnetisable fragment in the intra-ocular tissues depends on several factors, but more especially on the infective complications and the hæmorrhagic lesions caused by the penetration of the chip. The infective accidents occur with chips of all sizes, although naturally the larger fragments drag in more contamination from the usually infected conjunctival sac than the smaller ones—the infection leading to slight iritis, iridocyclitis with hypopyon, or even to panophthalmitis. Sometimes the extraction of the foreign body leads to a very favourable issue, but often the infectious processes continue, ending in the need for enucleation. As to the hæmorrhagic lesions, they may actually occur from section of vessels or from the contusion, and are related more directly to the size of the chip. **Morax** prepared a graph from some of the industrial and war accident cases at the Lariboisière, Paris, in recent years, the first graph dealing with 59 cases of intra-vitreous magnetic chips extracted by the electro-magnet, but discarding the cases where the chip lodged in the iris, anterior chamber, or lens. The following Table I (simplified for purposes of reproduction) gives the substance of the graph. In this table the weight of the fragment from 1 milligram and less up to 10 centigrams is given, and at the side four classes of results:—

A. Very satisfactory functional results, *i.e.*, V.=½ or more;
B. Useful results, *i.e.*, V.=1/10 to 1/2;
C. Functional result, *nil*, but globe retained, *i.e.*, V.=less than 1/10;
D. Enucleation necessary for hæmorrhagic lesions or infectious complications.

TABLE 1.—*Results of 59 extractions of magnetic chips from vitreous, arranged according to the weight of chip.*

	1	2	3	4	5	6	7	10	20	30	40	60	Milligrams 100
A. V.=½ or better...	3	2	1	0	1	0	1	0	0	0	0	0	0
B.V.=½–1/10 ...	8	5	0	1	1	0	0	3	1	0	0	0	1
C.V.=0 or below 1/10	4	0	1	0	0	2	0	3	0	2	3	1	2
D. Enucleation ...	0	2	1	0	1	0	1	1	1	0	0	3	3
Total cases	15	9	3	1	3	2	2	7	2	2	3	4	6

The very satisfactory results occur chiefly in cases where the foreign body is not more than 7 milligrams, *i.e.*, 8 times out of 35 cases, and if one adds the 15 useful cases, one gets 23 appreciable results out of 35, *i.e.*, two-thirds of the cases. In the 12 cases where the results have not been favourable, one finds 7 cases with vision equal to *nil* or less than 1/10 and 5 enucleations. When the chip is 10 milligrams or over, the failures are preponderant. In the 24 cases of this series, there is not one very satisfactory result, and only 5 useful results and 8 enucleations. The exceptional case is that with a 10 centigram chip where useful vision was obtained.

Morax found corroboration of his views on the relationship between the weight of the foreign body and the gravity of the ocular lesion in the thesis by Mme. Mangini based on 54 observations on war foreign body cases under Rollet, where the giant magnet was successfully used.

TABLE 2.—*Results of 48 cases—war injuries (Mangini), showing weight of metal chip.*

	1	2	3	4	6	9	10	20	30	50	70-100	200	300	600+	Milligrams
V.=½ or more ...	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
V.=½–1/10	0	1	2	0	0	0	0	0	0	0	0	0	0	0	3
V.=0 or below 1/10 ...	1	2	2	1	1	2	8	2	2	4	2	1	1	1	30
Enucleation... ...	0	1	2	0	0	0	2	0	2	2	2	1	1	2	15
No. of cases ...	1	4	6	1	1	2	10	2	4	6	4	2	2	3	48

This Table 2 shows how serious the results are with a magnetic fragment weighing more than 3.5 milligrams.

In Morax's second graph, Table 3 (again simplified for the purpose of reproduction), he draws attention to the different results obtained in the 59 vitreous foreign body cases as compared with the 15 iris, anterior chamber, and lens cases, where the proportion of satisfactory and useful results towers above that of the former.

TABLE 3.

	Intravitreous Foreign Bodies.	Iris, Lens, & Anterior Chamber.
V.=½ or more ...	Cases 8=13·5%	Cases 9=60%
V.=½–1/10	,, 20=34·0%	,, 4=26·6%
V.=0 or below 1/10 ...	,, 18=30·5%	,, 1= 6·6%
Enucleations	,, 13=22·0%	,, 1= 6·6%
Totals	Cases 59	Cases 15

In the one enucleation case of this group the foreign body was not extracted from the anterior chamber until one month after the war wound had been received. It is precisely the lack of weight that prevents the anterior segment foreign bodies from going deeper, so that it is necessary to compare the anterior segment cases with those vitreous ones where the chip is from 1 to 3 milligrams; but even then the prognosis is more favourable in the anterior segment group. In Mme. Mangini's thesis there are noted 6 anterior segment cases, and of these the result has been very good in 2 cases, *i.e.*, V.= more than 1/2, useful in 1 case, *i.e.*, V.= 1/8, functional result *nil* in 2 cases, enucleation in 1 case; in the favourable cases the weight of the chip was equal to or less than 3 milligrams.

Speaking of the relative value of the large and the small magnet, Morax says that each has its special sphere of usefulness. There is no invariable *technique* for the removal of these chips. According to the weight and seat of the foreign body, and the disorders which it has produced, or which it can still produce, so must the *technique* be modified. The anterior segment cases can generally be dealt with satisfactorily with the small magnet alone, while sometimes even the vitreous ones call for the small magnet. Such a case is quoted by the author where the giant magnet was used with the assistance of the ophthalmoscope for a vitreous foreign body, and yet the foreign body refused to come through the zonule. Scleral puncture had to be done, and the foreign body was recovered by the small magnet. After a week, the vitreous was still clear and vision full.

Morax finds the small pole that can be adapted to the giant magnet rather cumbersome. He considers that with delicacy and precision in the use of the giant magnet and with aseptic care the risks of the scleral route are not very great. He holds, however, that the special *rôle* of the big magnet is to coax the foreign body from the vitreous round the lens and through the pupil into the anterior chamber, whence it can be recovered by the small magnet after a corneal incision with the keratome. This is the method he has used, believing that it conserves best the delicate ocular tissues and gives the best chance of avoiding the risks of infection.

W. C. SOUTER.

III.—THE USE OF CELLULOID IN PLASTIC SURGERY.

Higgens, Charles.—A note on the use of celluloid in plastic surgery. *Lancet*, October 7th, 1916.

Higgens, of London, has lately had a considerable amount of experience of plastic surgery of the face, in connection with war

wounds. He soon began to recognise the want of a material which would make up deficiency of bone, fill up cavities, and level up depressed cicatrices. Paraffin was tried, but was not of great value, because of its tendency to "wriggle out of the position it was placed in." Deformity was but little improved. Celluloid was then tried, and experience has proved its value. Higgens has used plates of celluloid for replacing bone, and solution for filling cavities and raising deep cicatrices. For placing beneath cicatrices, Higgens, who formerly used plates for this purpose also, has now replaced the celluloid plates with a solution. There are two solutions, the one of a solution of celluloid in acetone, the other a secret trade preparation invented for making corks watertight. The latter is to be preferred. The method adopted is to make a tunnel under the cicatrix (subcutaneous detachment of the cicatrix) and then to inject the semifluid celluloid into the tunnel by means of a syringe with a screw-down piston. The syringe having been removed, a collodion dressing is applied to the wound. Major Pailing, a colleague of the author, has recently closed an opening in the skull with a celluloid plate. "The edges of the plate, which was curved to correspond with the curve of the skull, were pushed between the bone and dura and covered by the scalp." The result of this operation seems to have been excellent. Higgens considers there is a great future before the "celluloid operation." ERNEST THOMSON.

IV.—THE RELATION OF CHOKED DISC TO TENSION OF THE EYEBALL.

Parker, Walter R.—The relation of choked disc to the tension of the eyeball: an experimental study. *Journ. American Med. Assoc.*, October 7th, 1916.

Observations on the tension of the eyeball in cases of brain tumour led **Parker,** of Detroit, to think, that in cases in which the degree of papillœdema is equal in the two eyes, the ocular tension is equal, or nearly so; whereas, in those in which the swelling of the disc is greater in one eye than in the other, the tension is different in the two eyes, being less in the eye showing the greater degree of swelling.

The present communication is the record of an endeavour to prove by experiment the relation between choked disc and the tension of the eyeball, in the case of artificially increased intracranial pressure. The author refers briefly to the chief theories concerning the pathogenesis of choked disc, and although he does not commit himself, it is obvious that he favours the mechanical theory. He

then says, "The results obtained from experimentally produced intracranial pressure are as varied as the theories of the causation of papilloedema in brain tumour." He considers very briefly the experiments of Manz, Levinsohn, Cushing, Bordley, and others, and expresses the opinion that "the whole subject of the etiology of choked disc . . . is somewhat chaotic."

With a view of determining the effect that a difference in tension in the two eyes might have on the initial appearance or degree of papilloedema in cases of increased intracranial pressure, the following experiments were conducted :—

The tension of one eye was diminished by sclero-corneal trephining. After recovery from the operation, the intracranial pressure was increased and the effect on the two eyes observed. The experiments were carried out on 20 dogs and 3 monkeys by the following methods :—

The refraction of each eye was determined with the ophthalmoscope, and the tension taken with a Schiötz tonometer. The tension of one eye was reduced by a trephine operation. After recovery from the operation, a second ophthalmoscopic examination was made and the tension was again recorded. Artificial intracranial pressure was then induced through a trephine aperture in the skull : (1) by direct digital pressure ; (2) by the injection of normal salt solution under registered pressure ; (3) by the distension, under registered pressure, of an air-bag introduced between the skull and the dura ; (4) by the injection of paraffin through a brass cannula screwed into the skull ; (5) by the introduction of sea-tangle tents between the bone and the dura ; and (6) by the introduction of sponge tents between the skull and the dura.

The results are given in groups arranged according to the method employed to augment the intracranial pressure. Interested readers should consult the original article for details both of the experiments and of their results ; they will find there, in addition, a series of microphotographs of the optic nerves from several of the animals operated upon. A few of the results only can be given in this abstract :

GROUP 1. Digital pressure. Three dogs were subjected to experiment, but of these, 2 died too soon for observation. In the third dog, swelling of disc was quickly induced, and was greater by 4 to 6 dioptres (according to the duration of the pressure) in the trephined eye.

GROUP 2. Saline solution. Results inconclusive.

GROUP 3. Air-bag. Three dogs were used : 1 died from the anæsthetic ; 1 was a control in which no trephining of the eye had been done ; at a pressure of 200 mm. Hg. death ensued, and no measurable swelling of the discs had been induced. In the third dog, under a pressure of 20 mm., both discs became engorged, the

trephined eye first showing evidence of swelling; at 60 mm., the disc in the trephined eye was swollen 6D., the other 2D.; at 90 mm., both discs were swollen to 7D., and at a pressure of 280 mm. (when the dog died), the swelling was 8D. and equal in the 2 eyes.

GROUP 4. Paraffin. Three tests were made. In each the tension of the left eye was reduced by trephining, and the injection was made on the opposite side well back (*i.e.*, in reference to the trephined eye the tumour was contralateral). In all three the swelling was greater in the trephined eye, but "on the whole the paraffin was unsatisfactory; the œdema of the disc was never greater than 3D., and subsided in a few days."

GROUP 5. Sea-tangle tents. Results unsatisfactory.

GROUP 6. Sponge tents. Four observations were made, one being a control. In the others the tent was introduced on the side opposite the trephined eye. Dogs 1 and 2 died early. In the third dog, on the third day, the disc in the trephined left eye showed swelling of 3D.; that in the right eye, congestion but no swelling; seventh day, left disc 5D., right disc, 1D.; ninth day, left disc 6D., right disc 3D.; twenty-seventh day, nothing but congestion of both discs; forty-fifth day, both discs normal.

In the control dog, both discs became swollen on the third day, with a difference of 1D. between them. Dog died on the fourth day.

In the three monkeys, sponge tents were employed. In each experiment the tent was introduced on the side opposite to the trephined eye. In every case the swelling of disc appeared first, and was greater in the trephined eye. It is noteworthy that in two instances a return to normal or nearly normal tension in the trephined eyeball was followed by a subsidence of the papillœdema; and that a repetition of the trephining led to a recurrence of the swelling of the disc.

The author's conclusions are:—

1. Choked disc can be produced in the dog and monkey by artificially increasing the intracranial pressure. The most satisfactory results are obtained by the use of sponge tents.

2. When the intracranial pressure is increased by artificial tumours placed in the occipitoparietal region, one element in determining which disc will be affected first is the tension of the eyeball.

3. When the intracranial pressure is increased by artificial tumours placed in the occipitoparietal region, the nerve in the eye of least tension is the first to show the choked disc.

4. When the intracranial pressure is increased by artificial tumours placed in the occipitoparietal region, there is no direct relation between the location of the tumours and the eye first affected.

J. B. LAWFORD.

V.—REMEDIES.

(First Notice.)

(1) **Bader, A.—Clinical experiences of sub-conjunctival injections of potassium chloride in chronic disease of the uvea.** (Klinische Erfahrungen mit subconjunktivalen Kaliumchloridinjektionen bei chronischen Uvealerkrankungen.) *Zeitschrift für Augenheilkunde*, March-April, 1915.

(2) **Deutschmann, R.—Upon radio-therapy and intra-ocular tumour.** (Ueber intraokularen Tumor und Strahlentherapie.) *Zeitschrift für Augenheilkunde*, March-April, 1915.

(3) **Chance, Burton.—Recurrent sarcomata at the limbus treated by "electric desiccation."** *Trans. Amer. Ophth. Society*, Vol. XIV, Part ii, 1916, p. 550.

(4) **Snell, Albert C.—An epibulbar melanosarcoma of the limbus which completely disappeared under X-ray treatments.** *Trans. Amer. Ophthal. Society*, Vol. XIV, Part ii, 1916, p. 556.

(5) **Darier, A.—Introduction to ocular therapeutics.** (Introduction à la thérapeutique oculaire.) *La Clinique Ophtalmologique*, juillet, 1916.

(6) **Terson, A.—Ectogan in ocular therapeutics.** (l'Ectogan en thérapeutique oculaire.) *La Clinique Ophtalmologique*, juillet, 1916.

(7) **Terson, A.—On atropine conjunctivitis.** (Sur la conjonctivite atropinique.) *La Clinique Ophtalmologique*, juillet, 1916.

(8) **Simon. — Ionotherapy and episcleritis (salicylic ion and lithium ion).** [Ionothérapie et episclérite (ion salicylique et ion de lithium)]. *La Clinique Ophtalmologique*, juillet, 1916.

(1) **Bader,** of Bâsle, has already (*Zeitschrift für Augenheilkunde*, Bd. XXXIII, 1915) published an account of his researches upon the action of sub-conjunctival injections of potassium chloride solutions. These, carried out upon rabbits, led him to the conclusion that the action of the potassium salt was similar to that of sodium chloride, but more rapid and energetic.

The present communication gives an account of some clinical experiments with injections of potassium chloride alone, and of alternating injections of the chloride salts of soda and potash.

The author employed 1 per cent. and 2 per cent. solutions, combined with a ½, 1, or 2 per cent. solution of novocain.

He injected daily, or upon alternate days, 0·5 or 1 cm. of a 1 per cent. solution of potassium chloride, with a ½ or 1 per cent. solution of novocain (amount not stated); or double these doses, according to the nature of the disease.

The injections were made as follows:—

The conjunctiva was first anæsthetised with a few drops of a 2 per cent. solution of cocaine, and then the saline solution was slowly injected with a Pravaz syringe. The needle was entered at a spot 5 mm. from the limbus and pushed in for from 3 to 4 mm. When sodium chloride was injected, the eye was bandaged, and the patient kept in bed for two hours.

Bader admits that his experience is not yet sufficiently extensive to enable him to define the indications for, or the contra-indications against, the use of the potassium salt, but he finds that it is useful in cases which are suitable for sub-conjunctival injections of sodium chloride solution, but which call for more rapid and powerful treatment than is afforded by this salt.

The first case cited was one of disseminated choroiditis, which appeared after an attack of enteric fever. The Wassermann reaction is not mentioned, but it is stated that tubercle and syphilis were not present.

Two courses of sub-conjunctival injections of a 4 per cent. solution of common salt effected a slight improvement. Then a 2 per cent. solution of potassium chloride was tried. The result was astonishing. The turbid vitreous cleared up; the pathological changes in the fundus became more circumscribed; and the central and peripheral vision rapidly improved.

The second patient suffered from chronic irido-cyclitis, with vitreous opacities. Here, again, sodium chloride injections effected little, but potassium injections rapidly ameliorated the condition.

The third case was a similar one, but, as both eyes were affected, it was possible to use sodium injections for one eye, and potassium for the other. The latter showed a marked superiority.

The good results obtained were repeated in two more examples of chronic uveal disease.

Bader comes to the following conclusions:—

Sub-conjunctival injections of 1 and 2 per cent. solutions of chloride of potash are well tolerated by the eye. They are more painful than the corresponding solutions of sodium chloride, and should, in consequence, be combined with novocain. Whereas they act more intensively, they may be in a more dilute solution, and less of it can be used than would be necessary with sodium chloride. By stimulating the blood-vessels, the salt causes an active hyperæmia, which is effectual in causing the absorption of intra-ocular inflammatory products, such as vitreous opacities. In a word, we have at our command a new stimulant which is useful as an adjuvant to injections of sodium chloride, and which may succeed where the sodium salt has failed. T. HARRISON BUTLER.

(2) **Deutschmann,** of Hamburg, claims to be one of the first to employ radio-therapy in the treatment of intra-ocular tumours.

He describes a case in which one eye had been removed after an

accident. Later, a melanotic growth was discovered in the remaining eye. Rather than excise it at once, Deutschmann decided to try the effect of mesothorium.

He obtained a capsule coated with an equivalent of 10 milligrammes of pure mesothorium. The salt was covered with a silver plate, which served as the first filter. A rubber covering acted as second filter. An incision was made in the conjunctiva and a pocket fashioned into which the flat capsule was introduced. It was left *in situ* for an hour. This treatment was repeated upon several occasions.

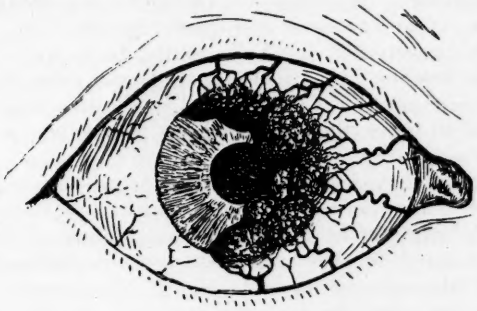
Deutschmann describes the gradual recession of the tumour. Unfortunately, the patient returned to South America, and nothing further was heard of him. This facts robs the communication of all interest, for most probably he went the way of most cases of unoperated melanotic sarcoma. T. HARRISON BUTLER.

(3) **Chance,** of Philadelphia, was consulted by a man, aged 58 years, for a growth upon one eye which had been present for about ten months. It was a nodular tumour, the size of a small bean, which protruded from the palpebral fissure, and which arose from the limbus of the left eye. It extended well into the cornea, to which it was adherent. Its colour was pearly-white, and large and tortuous vessels converged from the conjunctiva to meet at its base. Three weeks after excision, the parts looked normal, but in the course of two months, there was a nodular, and fungoid recurrence. A second and third excision were followed by recurrences. It was accordingly determined to try the method of "electric desiccation," and the patient was taken for that purpose to William L. Clark. Two applications were made, and some six weeks later, cure appeared to be complete. Pathological examination of excised masses of the growth showed that they were sarcomata. In a second case, in a woman of 37 years (under the care of P. N. K. Schwenk), a melanosarcoma, which had originated from a congenital mole, was present to the outer side of the limbus in one eye. It measured 6·5 mm. by 2·5 mm. It was not adherent to the cornea. The growth recurred after excision. This tumour, shown to be a pigmented sarcoma by pathological examination, disappeared after desiccation.

"Desiccation" is not the same thing as "fulguration," which consists in "the indirect destruction of tissue by the application of a current generated by an induction coil or transformer, through the action of which the nutrition of a part is so altered as to prevent the proliferation of cells." "Desiccation" is defined and described by Chance in the following words.—By "desiccation" is meant the dehydration of tissues by means of heat applied in the form of an electric "flame" produced by a high-frequency current, whereby the vitality of tissue cells is destroyed. The heat is generated by a

monopolar electric current of high tension, generated best by a static machine revolving at great speed, and then transformed by suitable appliances. The heat-flame, which must not be so intense as to char the tissues, flows from the point of a fine steel needle. The current from such an instrument can be regulated precisely, and the visibility of the flame affords one the opportunity to apply it exactly when and where the operator desires." Chance considers that "desiccation" offers distinct advantages over radium and other emergent rays. S. S.

(4) A man, aged 30 years, consulted **Snell,** of Rochester, N.Y., on account of the dark lobulated growth shown in the figure. V.=20/20, although the mass slightly encroached upon the inner



edge of the pupil. The condition had commenced five years before, and had been removed upon five different occasions. The patient, indeed, had been advised to have the eye enucleated in case of recurrence. Between October 31st, 1913, and January 31st, 1914, the X-rays were applied on twelve occasions, and a saturated solution of boric acid was kept constantly flowing over the cornea during each exposure. A medium soft tube was employed, two to five minutes being the time of exposure. The tube was placed as close to the eye as the glass cone would permit. Improvement was noted after the fourth treatment, which was discontinued when two-thirds of the area was healed. Six weeks after the last application of the X-rays, the entire tumour had disappeared. The cornea was clear. A few non-elevated deposits of pale brownish pigment extended from the limbus into the conjunctiva beyond. Nineteen months after the treatment, the patient was free from trouble.

It should be noted, finally, that the growth was reported by E. A. Shumway as a melanotic, epibulbar sarcoma of the limbus.

S. S.

(5) The reviewer has read with very great pleasure this article by **Darier,** of Paris. It is apparently a portion, perhaps the first chapter, of a new work on ocular therapeutics by the author, entitled *Compendium et Répertoire de Thérapeutique Oculaire.*

While there may be little in this article that is absolutely new, there is a great deal that is very recent. More than that, it conveys to the reader the why and the wherefore of many methods of investigation of a complicated character, in the most simple language possible and with the minimum of technicality. Since the book itself will shortly, we hope, be available in its entirety, it would serve no very useful purpose to take up the points in the present article *seriatim*. Nevertheless, there are some of these points which may well be referred to. The author divides the methods of diagnosis under the following headings, namely (*a*) Clinical diagnosis, symptomatology. (*b*) Anatomico-pathological diagnosis, microscopic and bacteriologic. (*c*) Experimental diagnosis, animal inoculation. (*d*) Sero-diagnosis, deviation of complement. (Bordet-Gengou, Wassermann, Cuti-epidermo-ophthalmo-reactions to tuberculin, Abderhalden's reaction). (*e*) Therapeutic diagnosis.

Under the heading Clinical Diagnosis, Darier gives the first place to the dentition, and reviews our knowledge in this direction. One feels justified in transcribing what he has to say on the subject of the first permanent molar as an indicator of syphilis.

"The canines may, in certain cases, be alone involved, but sometimes it is the first permanent molar which shows those stigmata of syphilis which Hutchinson has so well described for the front teeth. It was in 1900 that I made the first observations, and when, in 1904, I showed my casts to Sir J. Hutchinson himself, he admitted to me that he had not attached importance to molar lesions. He attributed these lesions to the influence of mercurial treatment. But it is easy to understand how the teeth which will be altered by syphilis will be those of which the ossification takes place at a time when this disease exercises its harmful effects. This explains why the first dentition is seldom involved: all the milk teeth have their ossification period in the fourth or fifth month of intra-uterine life; if syphilis affects the fœtus at this time, the latter is killed and abortion follows. If, on the contrary, syphilis manifests itself only in the final weeks of intra-uterine life, it will interfere with the development of the only tooth which receives its enamel cap at this time. That tooth is the first permanent molar *(première grosse molaire (tricuspide) permanente.)*" In a similar way the date of the syphilis can be determined by knowing the period of ossification of the other teeth. The whole of this paragraph on the dentition is of very great interest.

The main points for the understanding of the reactions of Wassermann, Noguchi, Abderhalden, and others are given in the clearest possible way, the author admitting, what is undoubtedly true, that at the present time most of these reactions are too complicated for the average clinician to carry out himself. He looks forward to the time when so much simplification of *technique* shall

have taken place that some of them at least may be handled by the practitioner.

Finally, we may say that if this chapter is a fair sample of Darier's forthcoming book, that book will be a most excellent and useful work of reference; not, perhaps, for the laboratory worker, but for the ordinary oculist practitioner. ERNEST THOMSON.

(6) Ectogan is described by **A. Terson**, of Paris, as a "derivative, of very pure type, of peroxide of zinc." It has been largely used in the course of the war as a dressing in powder form. It appears to have the advantages of iodoform without the inconvenience of the odour of iodoform. Terson has employed ectogan in the form of ointment, not as powder, in eye cases. The ointment is made up with equal parts of lanoline and vaseline, and is not used in greater strength than 2 per cent.; more usually, one gathers, Terson has used 1 per cent. He has employed this ointment in corneal and conjunctival affections and in palpebral dermatoses. Eczematous lesions tolerate the weaker percentage well, while, in ulcerative blepharitis the stronger is much preferable to either oxide of zinc or ichthyol. The author, however, does not make any comparison between this drug and mercurial preparations in blepharitis. His advocacy of the claims of ectogan would perhaps have been stronger if he had been able to show a superiority for the new drug over the older and well-tried mercurial ointments. ERNEST THOMSON.

(7) **A. Terson**, of Paris, mentions that one of his patients reacted in the direction of conjunctival irritation and lid swelling to atropine, duboisine, scopolamine, etc. Cocain and euphthalmin only, in spite of frequency of application necessary to obtain mydriasis in iritis, gave practically no bad results. In another case the use of atropine resulted in a follicular conjunctival inflammation of such intensity that any ophthalmologist might have been excused for making a diagnosis of trachoma. The case must have been rather remarkable, for the author says, "I have never before seen such an identity (with trachoma), and would never have believed that the ordinary follicular conjunctivitis of atropine could have covered *the whole* of the *upper tarsal* conjunctiva with such voluminous products *(productions)* so absolutely crammed one against the other. Nevertheless, six weeks after the substitution of euphthalmin for the atropine, the upper tarsal conjunctiva had entirely recovered its physiological polish and transparency."

ERNEST THOMSON.

(8) The article by **Simon** is of much interest, more especially if his results of ionotherapy in episcleritis can be confirmed. Presuming that episcleritis is of rheumatic or gouty origin, then the obvious thing to do is to bring the necessary drugs into absolute contact with the affected tissues. Internal treatment, and even treatment by subconjunctival injections, does not do this so

satisfactorily as ionization. The author has had a special eye bath made. It is of glass, and has two apertures in the bottom, for the admission and exit respectively of the fluid to be used. This is salicylate of lithium, chemically pure, of 1 per cent. strength. In the side of the bath [is] a carbon *plaque* attached to a terminal. The current used is, in the case of a salicylic ion, 1 or 2 milliampères, and in the case of the lithium ion, ½ milliampère. The time of application seems, for the cases recorded, to be 5 or 6 minutes for the salicylic ion and 3 minutes for the lithium ion. To obtain the action of the salicylic ion, the negative pole is at the eye-bath; to obtain the lithium ion the positive is in this position. As a matter of practice, the author seems to have employed the salicylic ion for about 6 minutes, and then to have reversed the current, so as to get the lithium ion, for 3 minutes. A number of cases are reported, and although one or two of them were rather rebellious and took some time, the majority seem undoubtedly to have been first relieved of pain and then cured in a few days, after one or two *séances*. Certainly, from one's ordinary experiences of episcleritis, one would say that the author's results are very good indeed. He makes no pretence, it must be said, to have used no other treatment; but, even allowing for the use of constitutional and local treatment of the ordinary kind, the rapidity of the appearance of good effects is distinctly striking.

ERNEST THOMSON.

BOOK NOTICE.

The American Encyclopædia and Dictionary of Ophthalmology. Edited by Casey A. Wood, M.D., C.M., D.C.L., assisted by a large staff of collaborators. Volume IX.—Institutions for the Blind to Limotes. Chicago: Cleveland Press. 1916.

The ninth volume of the *American Encyclopædia and Dictionary of Ophthalmology* commences with the second portion of the work on Institutions for the Blind; that, namely, which deals with American Institutions. It finishes, except for a few dictionary definitions, with an account of the "Legal Relations of Ophthalmology," which runs to some 150 pages. This work is by T. H. Shastid and is the gem of the volume. Within the reasonable compass of an article, a more scholarly and complete exposition of the subject can hardly be imagined. Here and there flashes of humour illuminate a rather sordid tract of country and help to relieve the gloom with which most of us regard it. Indeed, when it is considered that by the time all the volumes of the *Encyclopædia* have appeared in print, this writer must have contributed a number of biographies, at a rough guess, running into three figures, one is

lost in admiration of the versatility which enables one man to write equally well on such different lines of thought. That a certain portion of Shastid's articles may have appeared before does not lessen that admiration.

After an introduction, which deals with Court Systems and Basic Legal Principles in America, England, France, Germany, and Italy, ophthalmic expert testimony is considered, and, so far as legal aspects are concerned, each of these countries is separately reviewed. Under medical and surgical considerations are to be found, among much else, most sensible views upon simulation and dissimulation, false attribution, and exaggeration. Visual economics is scientifically treated, a full explanation being given of Magnus and Würdemann's formula for estimating the earning ability. This formula is:

$$E = C\ (\text{max.})\ \sqrt{P}\ \sqrt[4]{M}\ \sqrt{\frac{C_1 + C_2}{2}\ \sqrt{P}\ \sqrt[4]{M.}}$$

Of this formula the author, in one of his humorous touches aforementioned, says: "Now, while this formula, at first sight, appears a little complicated, it is really rather simple." We may leave it at that, trusting that the student will find it so.

The third main heading is Ophthalmo-sanitary Legislation in the five countries named. Under this comes the medical inspection of school children. Here one may be pardoned for pointing out that the author is hardly up to date when he says that in England (? surely he means Britain), "No arrangement has ever been made for treating." The statement is positive and sweeping, but it happens not to be true at the present date, although doubtless it was accurate enough some, shall we say, five years ago!

Lastly comes a most interesting, and at times entertaining, chapter on Malpractice. A few of the good things may be quoted. Says the author: "Surgery means snags, and he that does much surgery will sooner or later discover himself entangled in snags of a legal kind." Again: "It will have been observed in nearly all the cases just related, that the real, the fundamental, the underlying cause of the suit . . . was (either by intent or otherwise) another doctor. This fact should give us pause." And in the same connection: "The defendant in nearly every instance, was an unusually competent man." Almost the last words of Shastid's article are these: "An excellent ophthalmic surgeon of my acquaintance has been sued, or threatened with suit, no less than seventeen times. And, though no judgment was ever rendered against him, the worry has hurt him and aged him vastly more than all his work. Moreover, in nearly every instance, the cause of his trouble was either the malice or the thoughtlessness of a fellow practitioner. . . . All

this sad state of affairs with regard to medical and surgical malpractice could easily be different. In the first place, the French standard of responsibility should be adopted everywhere. The physician should be held accountable only for violations of clearly established principles—in a word, for gross negligence or gross lack of skill. Furthermore, expert evidence, in all these cases, should be really expert." With the views here expressed no medical man is likely to disagree.

Space does not permit of detailed notice of the other articles in this volume of the *Encyclopædia*. One has only to mention such subjects as "Iris" and "Iridectomy," "Keratitis" and "Krönlein Operation," "Laboratory Technique" and "Lacrymal Apparatus," to show the importance of the volume. The biographical notices include those on Hughlings Jackson, Javal, and Knapp.

ERNEST THOMSON.

NOTES.

Deaths.

WITH regard to the death of Wilbur B. Marple, which occurred suddenly at Kennebunkport, Maine, on September 30th, 1916, his surgical colleagues of the New York Eye and Ear Infirmary have placed upon record the following resolution:

"Dr. Marple had been connected with the Infirmary for 25 years, first as Assistant-Surgeon and from 1901 to the time of his death, as Attending-Surgeon. He was also for a number of years one of the representatives of the Board of Surgeons on the Board of Directors.

"The death of Dr. Marple has removed from among us a distinguished ophthalmologist, admired colleague, wise councillor, and honoured friend. His loss is greatly deplored by all of us. The Board of Surgeons desire to express their appreciation of his high professional attainments, and extend to his bereaved family their profound sympathy."

(Signed) "JOHN E. WEEKS, M.D.
EDWARD B. DEUCH, M.D.
W. E. LAMBERT, M.D."

The death has occurred of Dr. A. Fraenkel, the discoverer of the pneumococcus of pneumonia, at the age of 68 years.

The death is announced of Miguel Santa Cruz, director of the National Ophthalmic Institute in Madrid.

A former Ophthalmic House Surgeon at the Royal Infirmary, Sheffield, Surgeon Gordon Alan Walker, R.N., was, we regret to learn, killed in action on November 14th, aged 28 years. One of his brothers was killed on July 1st last, and another is a prisoner of war at Ruhleben.

We regret to learn of the death of Herbert Vigers Hickman, M.B.Lond., formerly ophthalmic assistant at Guy's Hospital.

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The late Professor McHardy.

A TABLET to the memory of the late Professor Malcolm McHardy was recently unveiled by Miss Ellen Terry, at the Royal Eye Hospital, Southwark.

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Ophthalmological Society.

THE next Annual Congress of the Ophthalmological Society of the United Kingdom, will be held, under the Presidency of Mr. Walter H. Jessop, in London, on Thursday, Friday, and Saturday, the 3rd, 4th, and 5th of May, 1917. One of the most interesting features of what promises to be a very interesting meeting, will be a visit to St. Dunstan's, Regent's Park, and a discussion on "Employment of the Blind," to be opened by Sir Arthur Pearson, Bart., and Messrs. W. C. Rockliffe, H. Grimsdale, and A. Lawson. The Bowman Lecture on "Colour Vision," by Sir George Berry, LL.D., M.D., will be delivered at 5.30 on the afternoon of May 3rd. The meetings of the Congress will be held at the Royal Society of Medicine, 1, Wimpole Street, but the Clinical Meeting will take place at Moorfields Hospital on May 4th. A discussion on "Concussion of the Visual Apparatus," to be opened by Mr. A. W. Ormond and Dr. S. A. Kinnier Wilson, has been arranged for the morning of May 5th, at 1, Wimpole Street, W.

Members wishing to lend ophthalmoscopes of historical interest to the Special Exhibition of Ophthalmoscopes should communicate with Mr. W. H. McMullen, 4, Chandos Street, London, W.

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Gifts and Bequests.

MR. AND MRS. PLAYER, of Clydach, Swansea Valley, have given £2,000 to Swansea General and Eye Hospital.

The late Mr. Alfred Edmonds, of Wolverhampton, has, among other legacies, left £1,000 to the Counties Eye Infirmary and £500 to the Society for the Blind.

FUTURE ARRANGEMENTS.

1917.

Midland Ophthalmological Society	February 6th.	Birmingham.
Section of Ophthalmology, Royal Society of Medicine.	*February 7th.*	*1, Wimpole Street,* London, W.
Midland Ophthalmological Society	April 3rd.	Birmingham.
Ophthalmological Society of the United Kingdom	May 3rd, 4th, and 5th.	London.
Midland Ophthalmological Society	June 5th.	Oxford.
Section of Ophthalmology, Royal Society of Medicine.	June 13th.	1, Wimpole Street, London, W.